Compressed Air Magazine

JUNE 1947

THE NARROWS
MALIGNE LAKE

A bit of scenic grandeur in Jasper National Park Alberta Province, Canada

PHOTO, NATIONAL PARKS BUREAU, CANADA

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ADVERTISING INDEX

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ON THE COVER

THIS is the season of the year when Nature beckons to all of us and our thoughts turn to a vacation out of doors. Most of us go where time, finances, and family conditions will permit, but hosts of men have at least dreamed of some day breaking all ties with civilization and setting up a simple camp where neighbors are few and far between and reminders of the workaday world do not exist. That type of man will envy the tranquil canoeists shown in our cover picture. Others, even though they prefer a vacation surrounded by modern comforts, will thrill to the majestic beauty of the view.

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IN THIS ISSUE

OUR leading article tells how Uncle Sam, by way of keeping his powder dry, is laying up a goodly percentage of the ships of our fighting fleets in such a manner that they can, if needed, be quickly returned to action. An article on cooling towers that starts on page 142 is primarily for engineers and operators but contains a wealth of information on a subject that has been given little attention in trade literature. Roy G. MacFarland describes new techniques that are speeding up shaft-sinking operations in the Coeur d' Alenes (page 149).

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BUY SAVINGS BONDS

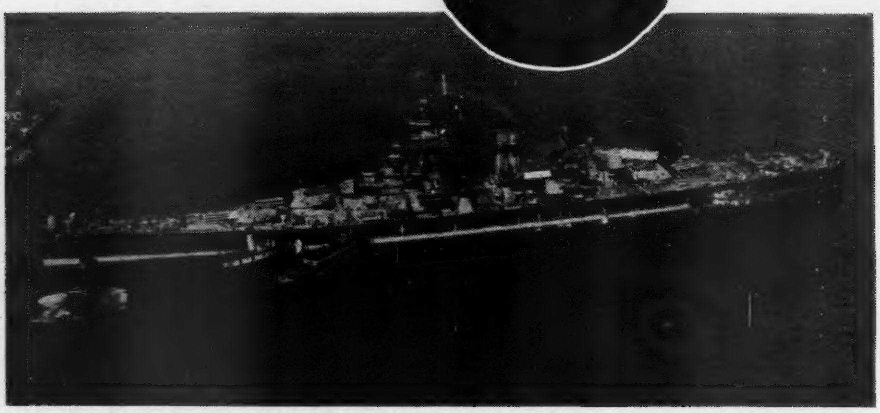
SINCE the war ended, the value of outstanding U. S. Savings Bonds has increased almost 10 percent despite cash-ins and maturities. This is a creditable record and indicates that Americans, by and large, are still in a saving mood. It is good business for the individual to save now, because the dollar promises to have greater buying power a few years hence. It is likewise patriotic. It helps spread the national debt among the people, who now hold $44,000,000,000 worth of Savings Bonds, in addition to other government securities valued at $21,000,000,000. Receipts of $10,000,000,000 from Savings Bonds since the Victory Loan have covered payments of maturities and redemptions of all Savings Bonds in the intervening period and created a fund of $2,000,000,000 to retire other securities as they mature. It is apparent that the sale of additional Savings Bonds does not increase the national debt.

Most industrial concerns still have payroll deduction plans for financing employee bond purchases. For the accommodation of those who work elsewhere, the nation's banks, beginning this month, will, upon request, buy a bond a month for any depositor and charge his checking account.

All Official U. S. Navy Photos

Putting Fighting Ships in Moth Balls

R. G. Skerrett



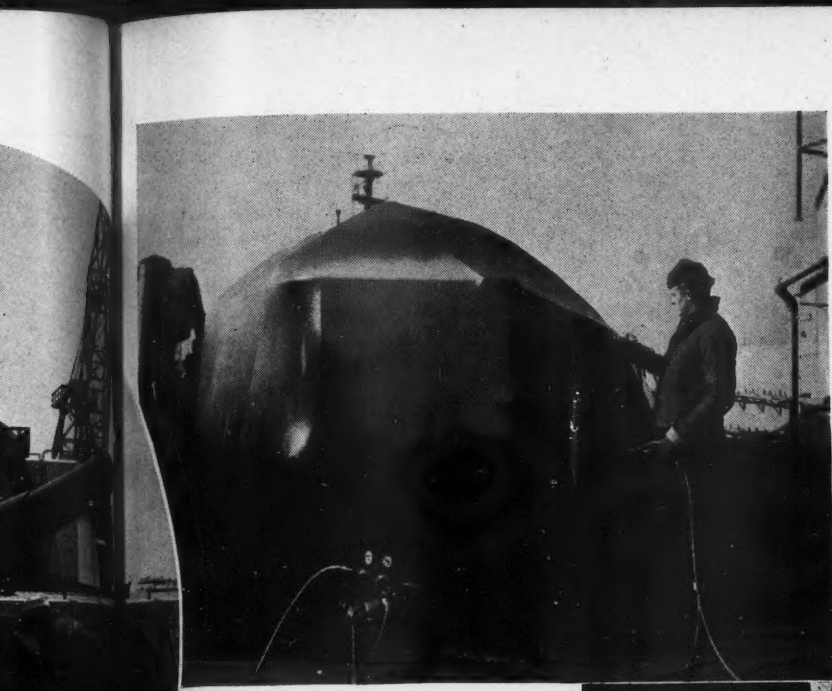
OUR pioneer, sharpshooter forefathers survived the hazards confronting them because they kept their powder dry and their rifles cleaned and oiled and within easy reach. The U. S. Navy is now doing in principle the same things by placing two great fleets of our battlecraft in reserve in a way that will make it possible to ready them quickly for active service. They are being safeguarded in their inactive status from the damaging actions of rust, corrosion, mildew, and even dust—arch enemies of these steel structures filled with multiple and complex equipment.

After the Spanish-American War of 1898, fewer than 100 of our steel fighting ships were put in reserve with reduced but sizable complements to keep them in condition. Those vessels deteriorated rapidly, and few if any of them were of the slightest military value when we joined in World War I. After that conflict our active fleet was soon reduced by placing about 400 of its ships in reserve. Their personnels were withdrawn, and their supervision was turned over to shipkeepers—civilians—who were based on shore.

The craft were generally larger, type for type, than their predecessors and, for various reasons, subject to faster deterioration. The untrained caretakers were few in number and not qualified to take proper protective measures. In a crude fashion steel surfaces were coated with heavy grease, but machinery was often so dismantled as to expose it to corrosive action. Before the vessels were laid up, all perishable and frequently all essential durable supplies were sent ashore. Many were nearly stripped to the bone, and indispensable fixtures and loose gear were put in storehouses without identification. On fair and assumed "dry days" hatches were opened to give the ships an internal airing in the belief that certain materials on board could thus be safeguarded from mold and mildew. No one gave any heed to the relative humidity of the outside air at such times. The procedure led up to a shocking revelation about three years before we entered World War II.

In 1938, when the President called upon the Navy to make some of the reserve craft fit to join our Atlantic patrol against enemy submarines, only six could qualify for that service by 1939. And when the much-discussed transfer of 50 of our "preserved" destroyers to Great Britain was arranged,

PRESERVING OPERATIONS
The battle cruiser "Alaska" is shown at the bottom left as it is being moved into a dry dock at Bayonne, N.J., to undergo inactivation treatment. In circle, plywood plates, later to be made airtight with plastic, are being bolted in place to close ports in a 12-inch gun turret. At the extreme left an officer is inspecting one of these sealed openings. A packaged 40-mm. gun mount is pictured at the left. A moisture-proof vinylite covering has been sprayed around it and a crew member is giving it a final coat of aluminum paint to reflect the sun's rays that might otherwise hasten deterioration of the envelope. Below is the after main deck of a cruiser that has been safeguarded against corrosion for twenty years but that can be reactivated in ten days.

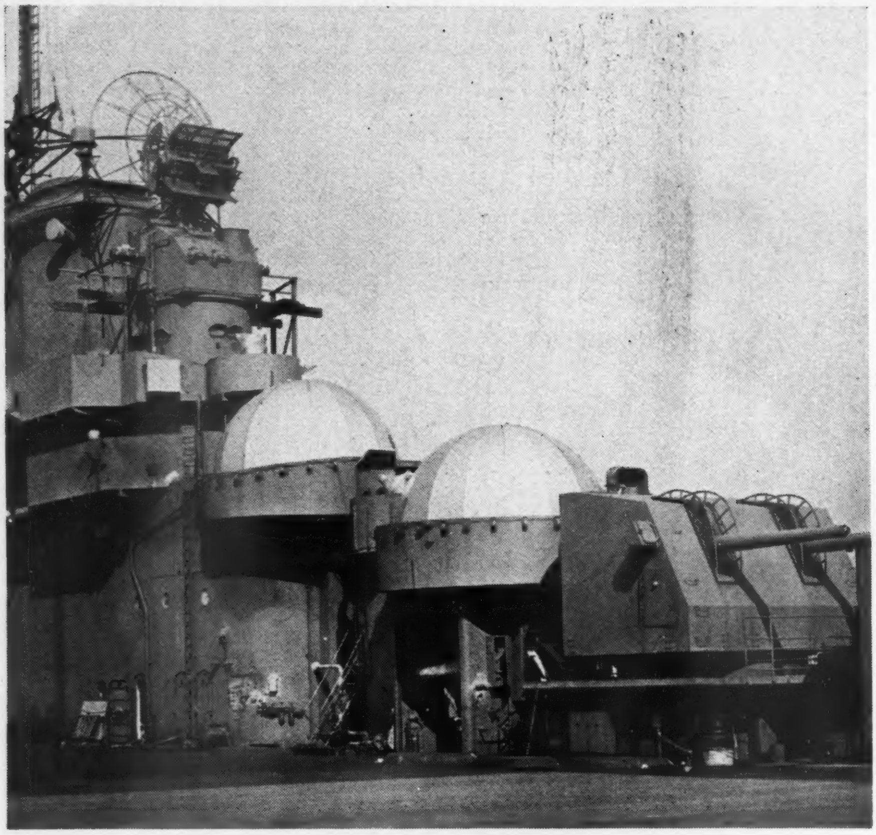


only four of our Atlantic bases could make good their quotas because those destroyers were far from the expected condition for readying and we actually had to draw upon our active fleet to meet our commitments. Later, when we entered the conflict, it took an average of seven months to make a reserve destroyer fit for sea duty and nine months to prepare a submarine. Those experiences thoroughly aroused the naval service.

Before then, however, experts of two technical bureaus of the Navy Department—since merged in the Bureau of Ships—had initiated research work to determine how fighting craft could be protected from impairment while in reserve and yet permit quick refitting for combat. That was something absolutely new. The aim was to evolve preservative measures that would be low in first cost and maintenance and would safeguard vessels from the harmful actions of moisture-laden air, which is stealthy in its penetrativeness and causes rapid rusting and corrosion when conditions favor. It was a hard task, one with little in the way of precedent to guide the men, but that did not deter them or their associates mustered from civil life. Much of the preparatory work was done in the Industrial Test Laboratory of the Philadelphia Naval Shipyard, and practical applications were made aboard two old craft. Gradually there was developed an all-inclusive protective system, together with suitable means and materials, by which it is possible to seal a vessel quickly for a decade or more.

The inactive status of a vessel demands that all her normal berthing and messing facilities be kept in place and immediately available should her full complement be ordered back for active duty, for reserve shore stations are not equipped to house and care for additional personnel. The refrigerating plant and other necessary services aboard must be kept fit for prompt reuse, requirements that are in sharp contrast with previous practices.

Before a ship is inactivated, she is thoroughly inspected to make sure that her hull, ordnance, machinery, and other fixed equipment are in good working condition. Any essential apparatus that is broken or missing must be repaired or replaced. When actually assigned to her station in a reserve group, the vessel must carry properly stowed a full allowance of her prescribed equipage and operating supplies. Only perishable stores are removed. This avoids difficulties in times of urgency when, as experience has proved, it is hard or im-



STEEL UMBRELLAS

Fire-control instruments and 40-mm. guns on this airplane carrier are protected by domelike structures of sheet steel that were developed by the U. S. Bureau of Ordnance. The sealed sectional coverings are, in turn, protected by three coats of special aluminum paint.

possible to get large quantities of such things as spare parts and tools of special make that may have become outmoded on account of changes in design or manufacturing methods.

Two thousand or more ships will form what will be known as the Pacific Reserve Fleet and the Atlantic Reserve Fleet—the latter including groups located on the Gulf Coast. The heads of the organizations are the Commander of the Eastern Sea Frontier and the Commander of the Western Sea Frontier. The inactivated vessels will be assigned to widely distributed areas for strategic and other reasons. Those constituting the Atlantic Reserve Fleet are being berthed at Boston, Mass., New London, Conn., Bayonne, N. J., Philadelphia, Pa., Norfolk, Va., Charleston, S. C., Green Cove Springs, 35 miles south of Jacksonville, Fla., and at Orange, Tex. On the Pacific Coast they are stationed at Bremerton, Washington, Seattle, and Tacoma, Wash.; Tongue Point, Oreg., near Astoria; at Mare Island and other points on San Francisco Bay, with the southernmost California group at San Diego. The outlay for the berthing facilities of the two fleets, including the various shore installations, is estimated at $100,000,000—a sum that is said to be less than one percent of the original cost of the ships.

Most of the vessels were designed and built during World War II and reflect amazing advances in naval architecture and marine engineering—incidentally the lessons learned during that conflict. They represent a source of national strength and, as adjuncts to our powerful active fleet, are of tremendous military value. Placing them in reserve is a truly monumental job: strenuous in its preparatory stages and from then on calling for exacting supervision. Now for the details.

Each craft is sent to a naval shipyard for dry-docking, after which all perishable provisions, clothing, ammunition, and inflammable stores are removed. The vessel is then thoroughly cleaned, underwater repairs are made, leaks are sealed, sea connections are closed by welding cover plates over them, and her structural steelwork is spray-painted throughout. Where necessary, this is preceded by sandblasting or the use of pneumatic wire brushes and chipping hammers. Her bottom is sandblasted down to clean metal and given several applications of a special anticorrosive paint, over which are further sprayed several coats of a still secret antifouling paint. Particulars about this work are contained in an article on *Baffling the Barnacle* published in the October, 1946, issue of this magazine. It should be mentioned here that all berthing stations have their own dry docks equipped with power plants, pumps, and air compressors. Water and electricity are obtained from public-service companies where possible, otherwise the Government supplies them.

The hot plastic antifouling bottom paint costs about $1.75 per gallon mixed and can be applied to a 10,000-ton cruiser by spray guns for $4000, including regular docking charges. Fouling is of minor concern while ships are inactivated, but the anticorrosive properties of the paints are important because they protect the steel hull while afloat in either fresh or salt water. Exterior steelwork open to the weather is given two coats of zinc-chromate primer and a third at the edges of plates, weld lines, and lightening holes, where paint tends to pull away and expose the underlying metal to corrosive action. Zinc-chromate paint, which is bright yellow, is a recent anticorrosive discovery and is covered in this case with the familiar haze-gray paint.

In preparing many apparatus either for painting or for cloaking within a protective film, compressed air is used to dislodge dust, a method of cleaning that is especially effective for certain highly sensitive navigational, directive, and control mechanisms. On exposed decks —"topsides" in naval parlance—all matériel and equipment that do not permit of removal from or storage within a craft must be safeguarded where they stand against bad weather and the deceptively pleasant "fair days."

The smaller guns, searchlights, fire-control directors, and other appurtenances that have to remain on deck are now "packaged" in some form of moisture-excluding covering. This may consist of an airtight material made up of successive layers of air-sprayed vinylite chloride, plus vinylite acetate, plus ordnance oil and within which is placed a suitable desiccant to keep the confined air dehumidified for a considerable while. A glazed window in each package permits an observer to note any change in the color of the desiccant, an indication of impairment and that it must be removed and a fresh supply substituted. The drawback to this method is the need of cutting a passage through the envelope in the first place and resealing it after renewal of the spent desiccant.

The term "weather" means not only wind, rain, snow, or atmospheric moisture but also the action of the sun. This may be troublesome. Each vinylite package is therefore given a final coat of aluminum paint, which reflects heat, light, and ultraviolet rays and helps to minimize expansion and contraction that result in a "breathing" movement. This may open passages where the plastic wrapper contacts a deck or bulkhead and allow the outside air to enter. The cloak

of sprayed materials costs around 40 cents per square foot, and a mobile pneumatic unit for this work can be bought for $500. A 3-inch, 50-caliber gun can be encased by two men in six hours, but the envelope can be stripped off in a few minutes.

A later form of packaging for standing equipment exposed to the elements is a closely fitting covering made of light-gauge sheet steel tack-welded and rendered moistureproof by a calking compound. Where edges contact a deck or bulkhead they are flanged so they can be secured with fastenings that draw them air- and watertight against gaskets. Such a package is provided with one or more tightly sealed windows that can be opened for inspection or replacing of the desiccant. After the envelope is in position, its outer surface is cleaned and sprayed with three coats of special aluminum paint. In some cases the inclosed space is connected with the vessel's internal dehumidifying system, though the tell-tale indicator may be retained to reveal a leak that needs attention.

How a craft assigned to inactive status should be equipped internally to protect her from the harmful action of moist air was the major problem for the researchers at the Philadelphia Naval Shipyard. Atmospheric humidity varies with the seasons, with the time of day, and with the conditions peculiar to each section of our seaboards. The Florida and Texas berthing stations are in humid regions; but it will surprise most of us to learn that "well-nigh every summer evening" the atmospheric humidity at Philadelphia "rises to 90 percent or higher." Any acceptable system of dehumidification therefore had to be adaptable so as to meet the daily and hourly changes in the relative humidity of the free air. This has been made certain, and the ingenious apparatus now used to safeguard our ships may be given wider application in our industrial and national life.

Some years ago, the Navy experimented with the effects of differing percentages of atmospheric humidity on a wide variety of materials. To quote the official findings: "This research, together with scientific data from non-naval sources, leads to the conclusion that a relative humidity of 60 percent will inhibit mildew and mold; that corrosion of clean ferrous surfaces will not take place in an atmosphere of 35 percent or lower relative humidity; and that air of this degree of dryness, or slightly less, is not permanently harmful to almost all of the materials. Some materials, however, like cordage, are weakened by being stored in such an atmosphere, but upon being exposed to average atmospheric conditions rapidly take up their needed moisture, and, with it, recover their former properties.

"At the Philadelphia Naval Shipyard, a Noah's Ark collection of materials has been assembled in each of five test chambers, in which the relative humidity has been controlled for about a year at 15, 30, 45, 65, and 90 percent, respectively. There is no discernible difference between the excellent condition of materials in the two lowest humidity chambers, and only slight discoloration of bright steel samples in the 45 percent chamber. Of course, corrosion, mildew, and rot are extensive in the 90 percent chamber, and to a lesser extent in the 65 percent chamber . . . . In order to provide a margin of safety, the Navy has settled on 30 percent humidity as the one to be maintained in the interior of steel vessels. In wood hulls, 50 percent humidity was chosen as ideal. Unpainted, corrodible surfaces would not be entirely protected in 50 percent humidity, but would have to rely on protective coatings."

During their investigations, the researchers found several excellent American desiccants that can be used to maintain the air inside a vessel at any desired relative humidity, even though the free atmosphere be very humid. Two of these are activated alumina and silica gel, either of which can be reactivated by drying. Certain characteristics of the latter make it especially suitable for shipboard application. The Navy employs two systems of dehumidification: the "static" and the "dynamic." In the static system the desiccant, either in fabric bags or perforated canisters, is placed in packaged or otherwise isolated spaces and left there until it shows signs of having adsorbed its maximum of moisture from the ambient air. Then

PROTECTION AGAINST RUST

Compressed air is being used above to apply a thin film of rust preventive on the internal surfaces of some of the driving machinery of a cruiser prior to sealing the compartment. This process is known as "fogging." At the right inspectors are stopping for a close look on one of their daily rounds of an inactive ship.

the containers are removed and fresh or reactivated desiccant is substituted.

The dynamic system is the more complicated of the two because it operates automatically. It does its own reactivating; can be set to maintain the moisture content of a given compartment at any fixed percentage; and can keep a continuous record of the condition of the air within all the internal subdivisions of a vessel. Of course, suitable steps are taken to isolate the interior from the outside air. All smokestacks, ventilators, deck openings, air ports, and doorways in superstructures are sealed with the exception of a single passage leading from the main deck into each dehumidification zone. That doorway is opened and closed quickly when it has to be used.

So sealed from the external atmosphere, a ship undergoes systematic and thorough cleaning within to rid all metal surfaces of rust, corrosion, dirt, and dust in preparation for going in reserve. Air-operated wire brushes, chipping hammers, and possibly sandblast equipment are utilized for this work to save time and labor. Next, each compartment must be made watertight as well as airtight. This means testing structural seams, hatches, steel doors, and other passages by placing several normally interconnecting subdivisions under air pressure. However, a channelway of some sort must be left between adjoining compartments for the cyclic circulation of dehumidified air and the return of any moist air to the dehumidifying apparatus, where it is retreated. All openings not required in the dynamic system are closed tight with a nonhardening compound.

Bare metal surfaces that have been cleaned are air-sprayed with a prescribed rust preventive of the polar type in which a light kerosene derivative is the solvent. The film may be only two-thousandths inch thick when the heaviest of the three compounds is utilized, or as thin as three ten-thousandths inch when the lightest is used. That produced by the heaviest is transparent enough to make corrosion visible even in its incipient stage. These rust preventives are applied to all machinery, boilers, heat-transfer apparatus, piping systems, etc. According to Commander L. R. Mitten, USN., (Retired): "Machinery protected by these compounds can, with the addition of the regular lubricant, be placed in immediate operation without removal of the compound."

The nature of an article or a surface to be treated determines how it is to be coated. Spraying and dipping are the preferred ways because the film is more uniform and cracks and crevices are penetrated. Equipment does not have to be disassembled to reach inaccessible areas because the compound can be distributed either by flushing or "fogging." In the latter case it is atomized by means of a high-pressure air spray, which satisfactorily coats the interiors of turbines, gears, cylinders, boilers, etc. The inner surfaces of small piping systems also are treated by fogging or flushing. The compounds cost from 71 to 97 cents a gallon, and 10 gallons of the lightest grade will meet the requirements of an average ship. All those used by the Navy produce tenacious films that can be removed with any hydrocarbon solvent. It is seldom done.

The internal sections of a sealed vessel through which air is circulated by the dynamic dehumidification system include the principal structural subdivisions such as turrets, living spaces, engine rooms, boiler rooms, etc., in which the personnel carry on their activities continually. Infrequently opened or visited compartments are under the control of static dehumidification. The dynamic system, as has already been said, does several things automatically, and does them well. The incoming air, which enters a ship through intermittently opened weather-deck portals, is picked up at some high point in the superstructure and carried through piping to the recorder-controller of a dehumidification zone, the number of zones in any vessel depending upon her size and type. A battleship may have seven or eight, while a destroyer escort will have but one.

Each zone has its own dehumidification machine and recorder-controller, which is the heart of the dynamic system. The arterial arrangement is made up mainly of drained fire mains, ventilating ducts, and perhaps conduits of flexible fabric between parts that are normally not connected. At eight different points in this circulatory system there is a "humidity-sensing station," and all these are ingeniously linked with the central recorder-controller, which starts and stops the dehumidification machine. The latter can be adjusted to maintain any desired *average* humidity throughout its zone.

At each humidity-sensing station there is a humidistat—an improvement on an apparatus devised 200 years ago by a Swiss physicist. This instrument is actuated by the elongation and contraction of strands of human hair, which connect with electric circuits in which the transmitted current varies accordingly and so affects the action of the central recorder-controller. When the average of the readings induced by the currents from the eight humidistats reaches the average humidity for which the dehumidification machine has been manually set to function, the machine will automatically start or stop. The recorder-controller registers the humidity and the temperature at each sensing station every fifteen minutes, thus locating any station where the relative humidity has become excessive.

Briefly, a dehumidification machine has two associate but independent canisters, each charged with 175 pounds of desiccant for a large unit and 30 pounds for a smaller one. These cylinders are brought into service successively for extracting moisture from the intake air, which is forced by a blower or fan through the bed of desiccant and thence

SANDBLASTING

Many metal surfaces are cleaned in this manner to remove rust before applying protective compounds. Two sandblasters can do work in 36 hours that would require two weeks by chipping or scraping.

DEHUMIDIFICATION

The crewmen at the right are placing bags of moisture-adsorbent silica gel along a cruiser's drive shaft preparatory to sealing off that section of the ship. The area will be inspected periodically and the silica gel replaced when it is no longer effective. The view below shows a dehumidification machine that automatically keeps the humidity in the space it serves at not more than 30 percent. The two insulated upright cylinders contain a desiccant to extract moisture from atmospheric air that is forced through them and thence through a group of compartments by means of a blower. One cylinder serves until it has taken up its fill of moisture. The air is then automatically directed to the second cylinder. The seaman pictured at the lower-right is checking a humidity meter through a window in a gun mount.

through the distributing circuit of the zone. The canister remains in action until the desiccant has adsorbed its full measure of moisture, when it is cut out of the system by switching the blower to the neighboring cylinder. The spent one is then heated to reactivate its desiccant for reuse. Electric heating raises the temperature to about 300°F., drying the silica gel, for example, in a short time. The moisture extracted is discharged through a connection leading to the free atmosphere.

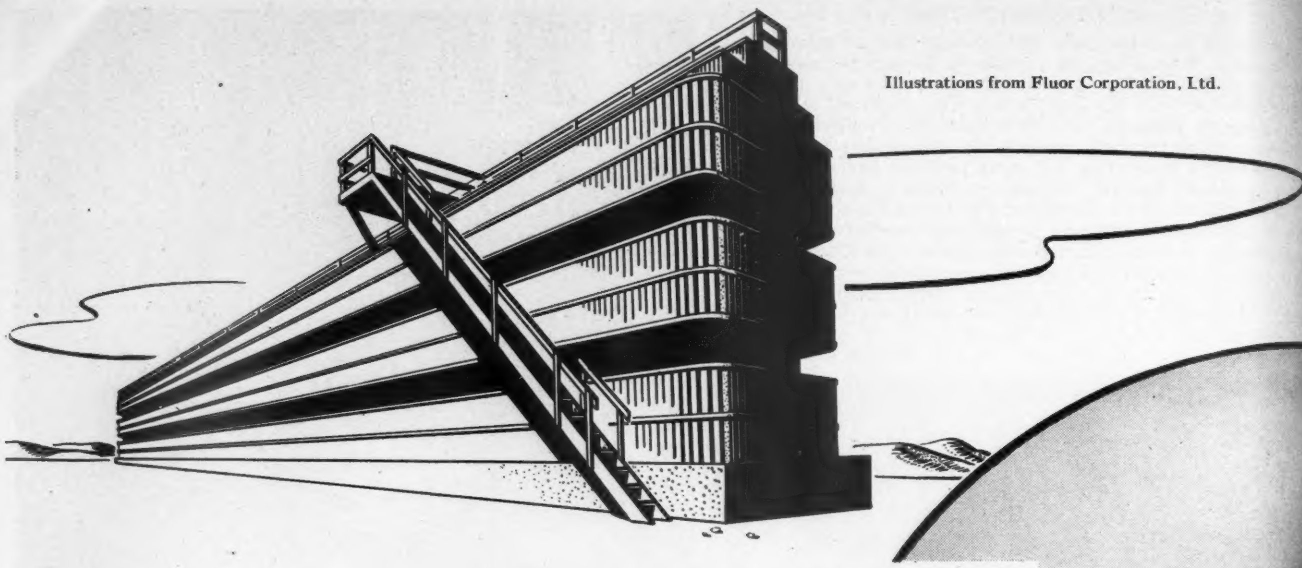
A small dehumidification machine costs about $1000 and will serve an area containing 150,000 cubic feet of air, while the large $1300 unit will take care of 400,000 cubic feet. The cost of maintaining 30 percent humidity in a steel ship is well below twenty cents per 100,000 cubic feet of space per diem, with power at one cent per kw.-hr. A pound of common silica gel can be had for 21 cents, and tell-tale silica gel, of which only a small quantity is needed, for 60 cents.

It is understandable that the load on the dehumidifier is heaviest at the start, and drops progressively as the moisture content of the air is brought down to the desired average maximum of 30 percent. Inspection of every compartment is made frequently during this period; but if all goes well the interval between them is lengthened to once every twelve weeks. By that time everything should be running smoothly, and a small organization will have no difficulty in supervising the inactivated vessels.

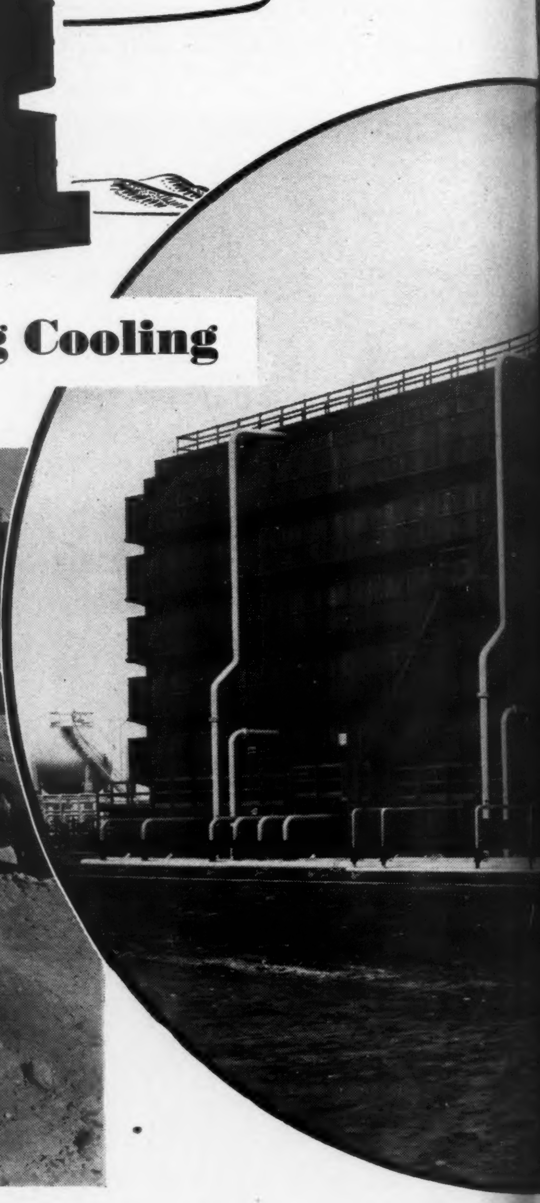
Let us take the Atlantic Reserve Fleet Organization, for instance, which is composed of eight groups distributed among the eastern berthing stations. Each is divided into "caretaking units" or Sub-Groups. Sub-Group One at Philadelphia has three battleships, five aircraft carriers, nine cruisers, three seaplane tenders, and one minesweeper. To maintain these 21 vessels in their inactive status a complement of only 60 officers and 570 enlisted ratings is necessary. In active service the personnel of a battleship would be about 2000 and that of a cruiser 39 officers and 677 enlisted men. The size of the force required in reserve is indicative of the economy effected by the new protective system. And it should be kept in mind that the reduced complements are made up of men who have been well trained for their assignments and who can be relied upon to do their work efficiently.

Whether the two great fleets are being made ready for a cat-nap or a prolonged sleep, nobody knows, but each ship is for the nonce a sheathed sword which will be found fit for service should the need arise. As Fleet Admiral William F. Halsey, Jr., USN., has said: "A nation no longer has time to develop weapons for its defense after war begins. Preparedness must be worked out in peacetime." The Navy has taken this truism to heart, and has acted accordingly.

This article has been made possible through Admiral Thomas C. Kinkaid, USN., Commander, Atlantic Reserve Fleet; Capt. H. B. Southworth, USN., Commander, New York Group Atlantic Reserve Fleet; and through the coöperation of the local officer in charge of the Atlantic Reserve Fleet's Office of Public Information.

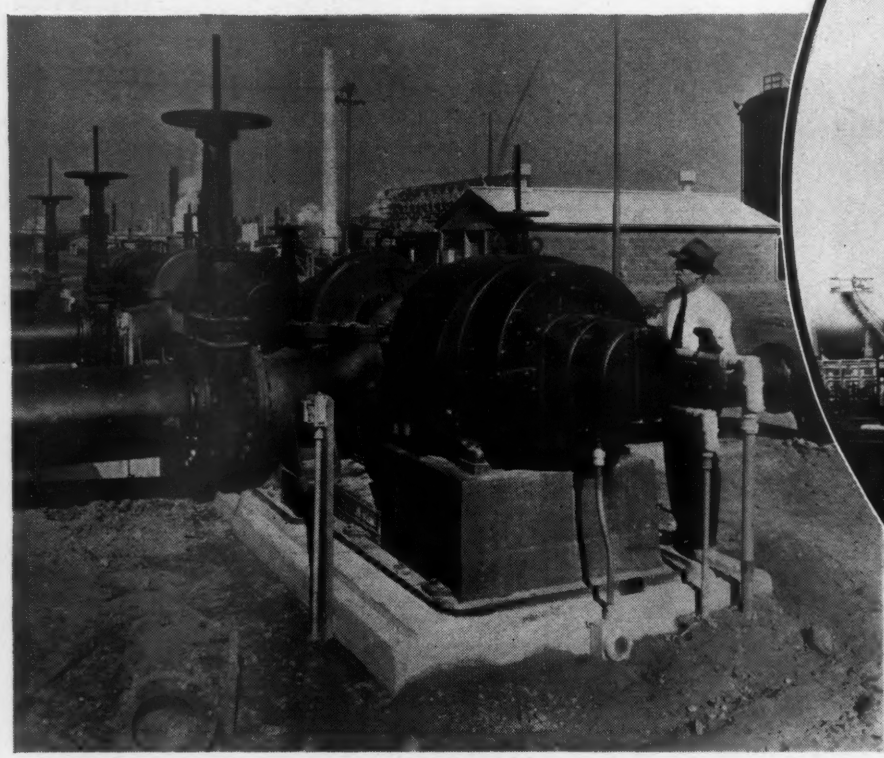


Illustrations from Fluor Corporation, Ltd.



Evaluating Cooling

*James G. De Flon**



WATER PUMPS

Water-circulating pumps are important adjuncts to all cooling towers, and some of the units are of large capacity. Shown here are three Ingersoll-Rand double-suction, single-stage centrifugal pumps stationed near the base of a cooling tower that serves a large West Coast plant producing gasoline by the fluid catalytic process. Each pump will handle 12,000 gpm. against 125 feet of head, and is driven at 900 rpm. by a 450-hp. splashproof synchronous motor.

THE processes of cooling water are among the oldest and simplest known. All that is needed to cool water is to expose its surface to air. Some methods, such as the cooling of water on the surface of a pond, are slow; while others, such as the spraying of water into air, are comparatively fast. All involve exposure of the water surface to air with varying degrees of efficiency.

The heat-transfer process involves a latent-heat transfer owing to the change of state of a small portion of the water from liquid to vapor, and a sensible-heat transfer owing to the difference in temperature between the water and air. The evaporation of one pound of water requires approximately 1000 Btu's, which is the amount of heat lost in cooling 100 pounds of water 10°F. (all temperatures cited are Fahrenheit). Therefore, for each 10° of cooling effected, roughly 1 percent of water is lost by evaporation. In addition, there will be a spray loss of not more than 0.2 percent in a well-designed atmospheric or mechanical-draft tower. Water cooling from 120° to 90°, for example, will, consequently, lose 3.2 percent of its weight (3 plus 0.2 percent) with each passage through the tower.

In cooling towers in which the water

*Chief cooling tower development engineer, The Fluor Corporation, Ltd.

is warmer than the air, the heat removed from the water and transferred to the air is the sum of the sensible heat and the latent heat of evaporation. The sensible heat q_s is small compared to the latent heat transferred, wr:

$$q_t = q_s + wr$$

$$w = kA\Delta p_m$$

The factors that influence the performance of a cooling tower are therefore those that affect the expression $kA\Delta p_m$. The value kA depends upon the construction of the equipment, the extent of the water surface exposed through drop surface and filming surface, and the velocity of the air. Δp_m depends upon the temperature of the water and the temperature and humidity of the air. Actually, Δp_m represents the difference in vapor pressure between the water at its temperature and the water if it were at the wet-bulb temperature of the air.

Although we do not often publish technical material, we are giving space to this article because cooling towers are used in many industries where our magazine circulates. We believe the article contains valuable information that has previously not been available to engineers and operating men. It is timely because plants are now preparing to handle increased heat loads during the hot-weather period. —Editor

It is evident from the foregoing statements that water cannot be cooled below the wet-bulb temperature of the entering air. The wet-bulb temperature, or, to be more precise, the adiabatic saturation temperature, represents the minimum temperature the water would reach after infinite time of contact between water and air in a cooling tower. This must be kept in mind when designing a plant to operate on cooling-tower water.

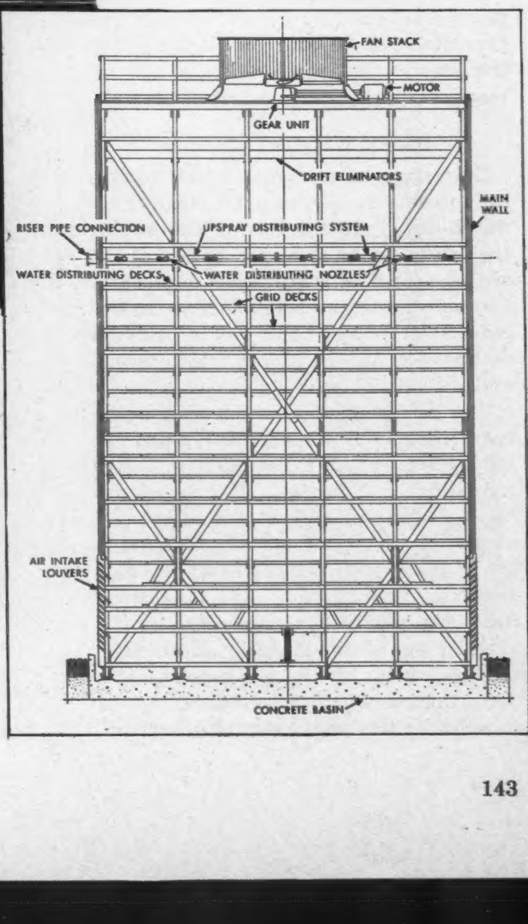
General Considerations

As process refinements have been made, industry has demanded closer and closer control of its production units, resulting in more exacting demands upon cooling towers. In many plants each additional degree of cooling has meant hundreds and even thousands of dollars per day in increased output. It has, therefore, been necessary for the cooling-tower industry to build units that would supply colder water more economically than earlier models.

Tower Performance

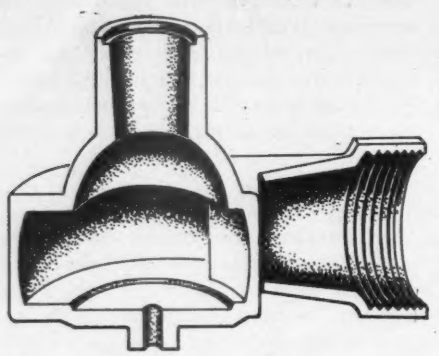
MODERN COOLING TOWERS

In the circle is shown an atmospheric-type tower used for cooling engine- and compressor-jacket water at a western natural-gas recycling plant. At its right is the pump house. In the view just above is a 3-cell mechanical-draft tower at a large midwestern industrial establishment.



MECHANICAL-DRAFT TOWER

Cross section of an induced-draft unit in which air entering at the bottom is drawn upward by a fan at the top. The water is pumped to a header near the tower top and sprayed upward. It mixes intimately with the exhaust air while falling on the uppermost of a series of distributing decks, through which it descends counterwise to the rising air stream. This brings the coldest water in contact with the driest air and the warmest water with the most humid air, insuring maximum cooling because the temperature of the cool water is approaching the wet-bulb temperature of the entering dry air. This does not occur in the older cross-flow and parallel-flow types of towers. Entrained moisture is removed from the exhaust air by the drift eliminators just below the fan. The effect of the upspray distribution system is equivalent to an 8- or 9-foot addition to the height of a straight gravity-type tower.



UPSPRAY NOZZLE

This nonclogging-type nozzle depends upon centrifugal force rather than on a small orifice to produce small drops that assure maximum contact with the air. The water is given a whirling motion by its tangential entrance into the spiral chamber. The removable bottom screw plate can be drilled as shown for automatic drainage to prevent winter freezing. Seven-pound pressure is common in upspray distributing systems, but one of 5 pounds is adequate. Nozzle capacities at 7 pounds pressure range from 1 to 46.5 gpm., depending upon size of orifice.

The two types of cooling towers in general use are the atmospheric and the mechanical-draft. These have almost entirely replaced the older means of cooling water; that is, the spray pond and natural-draft chimney towers. The objections to the spray pond are its limited performance and the high water loss during certain seasons. The objections to the natural-draft tower is the high initial cost and the serious reduction in performance during hot weather. Atmospheric as well as mechanical-draft towers are capable of cooling water to the same minimum temperature. The economic situation, the prevailing atmospheric conditions, the desired approach to the wet-bulb temperature, and the amount of space available will determine which type to select.

Mechanical-Draft Towers

Two types of mechanical-draft towers are in use: the forced-draft and the induced-draft. In the case of the former the fan is mounted at the base and the air is forced upward and discharged through the top at low velocity. In the induced-draft type the fan is installed on the roof and the air is pulled upward and discharged at high velocity.

The forced-draft tower is fast losing favor because it is more likely than the induced-draft type to recirculate the hot, humid exhaust vapors. This occurs under certain atmospheric conditions because the velocity of the exhaust air is so low that the suction induced by the fans tends to draw it back into the tower. Since the wet-bulb temperature of the exhaust air is considerably above that of the ambient air there is a decrease in performance, which is evidenced by an increase in the cold-water temperature. Except for the location of the fans, the structural and operational features of the two types of mechanical-draft towers are essentially the same.

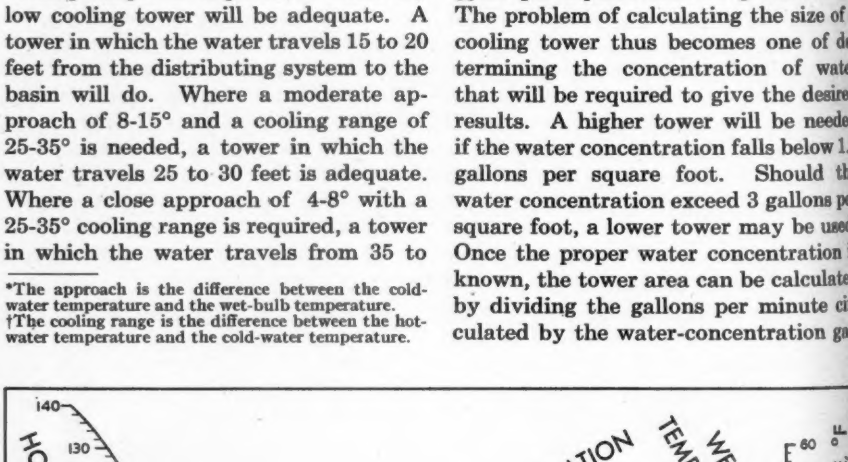
The performance of a given type of cooling tower is governed by the ratio of the weight of air to that of water and the time of contact between air and water. In commercial practice, the variation in the ratio of air to water is first obtained by keeping the air velocity constant at about 350 feet per minute per square foot of active tower area and varying the water concentration (gallons per minute per square foot of tower area). As a secondary step, the air velocity is varied to make the tower meet the cooling requirement. The time of contact between water and air is governed largely by the time it takes the water to issue from the nozzles and fall through the tower to the basin. The time of contact is, therefore, obtained in a unit of a given type by varying the height of the tower. Should the time of contact be insufficient, no amount of increase in the ratio of air to water will bring about the desired cooling. It is therefore necessary that a certain minimum height of cooling tower be maintained.

Where a wide approach* of 15-20° to the wet-bulb temperature and a 25-35° cooling range† is required, a relatively low cooling tower will be adequate. A tower in which the water travels 15 to 20 feet from the distributing system to the basin will do. Where a moderate approach of 8-15° and a cooling range of 25-35° is needed, a tower in which the water travels 25 to 30 feet is adequate. Where a close approach of 4-8° with a 25-35° cooling range is required, a tower in which the water travels from 35 to 40 feet will suffice. It is usually not economical to design a cooling tower with an approach of less than 4°, but that can be satisfactorily accomplished with a tower in which the water travels 35 to 40 feet.

*The approach is the difference between the cold-water temperature and the wet-bulb temperature.
†The cooling range is the difference between the hot-water temperature and the cold-water temperature.

Figure 1 shows the relationship of the hot-water, cold-water, and wet-bulb temperatures to the water concentration, and from it can be obtained the minimum area necessary for a given performance of a well-designed counterflow induced-draft cooling tower. Figure 2 gives the required horsepower per square foot of tower area for a given performance. These curves do not apply to parallel or cross-flow cooling, since these systems are not so efficient as counterflow cooling, neither do they apply where the approach to the cold-water temperature is less than 5°. The charts should be considered approximates and for preliminary estimates only. Many factors not indicated in the graphs must be included in the computations, hence the manufacturer should be consulted for final-design recommendations.

The cooling performance of any tower containing a given depth of filling varies with the water concentration. It has been found that maximum contact and performance are obtained with a tower having a water concentration of 2 to 3 gpm. per square foot of ground area. The problem of calculating the size of a cooling tower thus becomes one of determining the concentration of water that will be required to give the desired results. A higher tower will be needed if the water concentration falls below 1.6 gallons per square foot. Should the water concentration exceed 3 gallons per square foot, a lower tower may be used. Once the proper water concentration is known, the tower area can be calculated by dividing the gallons per minute circulated by the water-concentration gal-



FIGURE– 1 MECHANICAL-DRAFT-TOWER SIZING CHART

Performance curve of a counter-flow, induced-draft cooling tower with an upspray water distribution system and containing 24 feet of filling. To determine the size of cooling tower for a specified requirement, place a straightedge on the points representing, 1, hot-water temperature; 2, cold-water temperature; and, 3, wet-bulb temperature. Then read the water concentration. The quantity of water to be cooled divided by the water concentration gives the effective ground area of the tower.

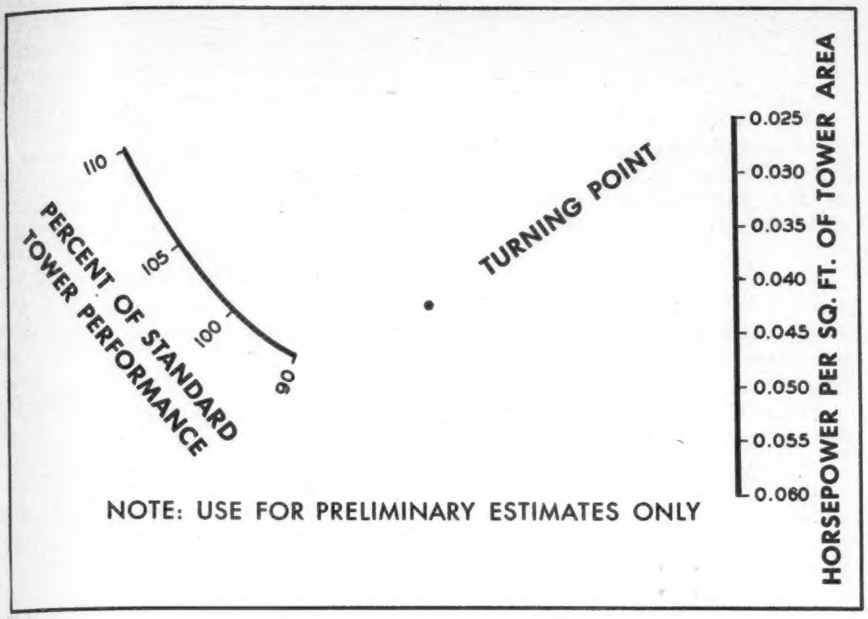


FIGURE 2– FAN HORSEPOWER CURVE

For estimating requirements of induced-draft towers with 24 feet of filling, place straightedge on percent of design tower-capacity factor and turning point, read fan horsepower per square foot of tower area, and then multiply tower area by this factor to obtain fan horsepower.

lons per square foot. The tower size is, then, a function of the following:

1. Cooling range (hot-water temperature minus cold-water temperature).
2. Approach to wet-bulb temperature (cold-water temperature minus wet-bulb temperature).
3. Quantity of water to be cooled.
4. Wet-bulb temperature.
5. Air velocity through the cell.
6. Tower height.

To illustrate the use of the charts let us assume that we have the following cooling conditions:

Hot-water temperature	=	102°
Cold-water temperature	=	78°
Wet-bulb temperature (Twb)	=	70°
GPM	=	2000

Laying a straightedge across Figure 1 and connecting the points representing the design water and wet-bulb temperatures, we find that a water concentration of 2 gallons per square foot is required. Dividing the quantity of water circulated by the water concentration, we find that the theoretical area of the tower is 1000 square feet.

To determine the theoretical fan horsepower we use Figure 2. Connecting the points representing 100 percent standard tower performance with the turning point, we note that 0.041 hp. will be needed per square foot of actual effective tower area. Multiplying this by 1000 square feet, the tower area, we find that it will take 41 fan horsepower to do the necessary cooling.

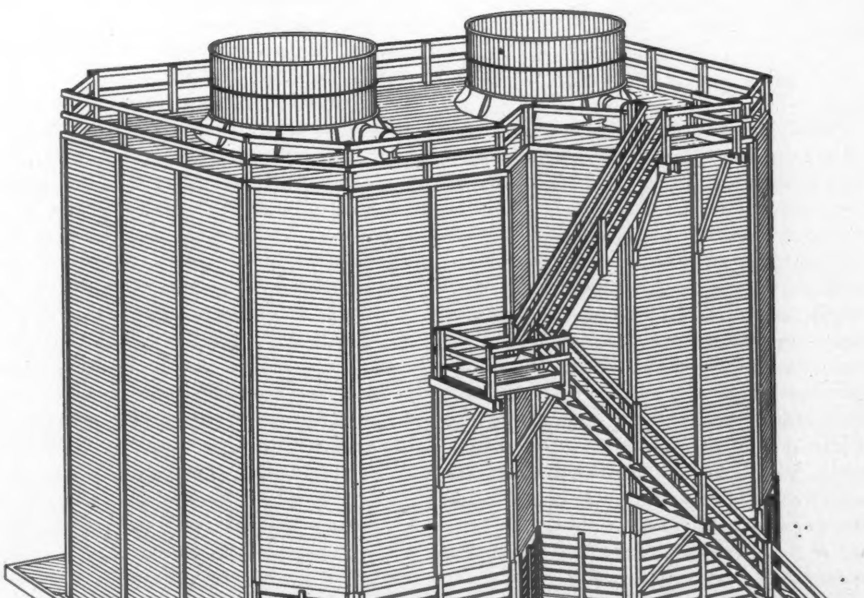
Supposing that the size of a commercial tower is such that the actual tower area is 910 square feet. We can still obtain cooling equivalent to 1000 square feet of standard tower area by increasing the velocity of the air traveling through the tower. Within reasonable limits, any shortage in actual area can be compensated for by an increase in air velocity, which, in turn, calls for more fan horsepower. Our problem, then, becomes one of increasing the performance of the smaller tower by 10 percent. By connecting the points representing 110 percent standard-tower performance and the turning point in Figure 2, the fan horsepower is found to be 0.057 per square foot of actual tower area, or 0.057 x 910 = 51.9 hp.

On the other hand, if the commercial-tower size is such that the actual tower area is 1110 square feet, then cooling equivalent to 1000 square feet of standard tower area can be accomplished with less air and less fan horsepower. By means of Figure 2 we determine that the theoretical fan horsepower for a tower giving only 90 percent of standard performance is 0.031 per square foot of actual tower area, or 34.5 hp. This illustrates how sensitive the fan horsepower is to small changes in tower area. The importance of designing a tower that is slightly oversize in ground area becomes immediately apparent.

Let's assume that we have the same cooling range and approach as in the first example, except that the wet-bulb temperature is lower. The design conditions would then be:

GPM	=	2000
Range	=	24°
Approach	=	8°
T_1	=	92°
T_2	=	68°
Wet-bulb temp.	=	60°

From Figure 1 we learn that the water concentration required for cooling is 1.75, giving a theoretical tower area of 1145 square feet, as compared with 1000 square feet for a 70° wet-bulb temperature. This shows that the lower the



TWO-CELL MECHANICAL-DRAFT TOWER

Note how the square corners have been eliminated in order to facilitate internal air distribution.

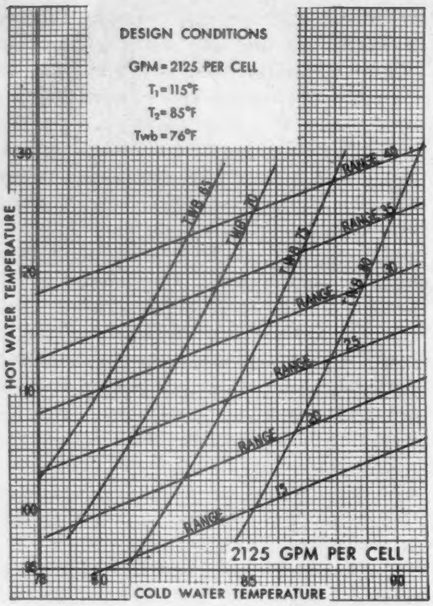


FIGURE 3

Typical performance curve for a mechanical-draft cooling tower.

wet-bulb temperature with the same cooling range and approach, the larger the tower area and therefore the more difficult the cooling job.

Plant operators are often faced with the problem of estimating the performance of an existing tower at other than design conditions. For example, suppose we have a tower that was designed for the following conditions:

$$\begin{aligned} GPM &= 1000 \\ \text{Range} &= 30^\circ \\ \text{Approach} &= 10^\circ \\ T_1 &= 110^\circ \\ T_2 &= 80^\circ \\ \text{Wet-bulb temp.} &= 70^\circ \end{aligned}$$

What will the cold-water temperature (T_2) be when the wet-bulb temperature (Twb) drops to 60°, provided, of course, that the heat load and water quantity remain constant? Figure 1 tells us that the water concentration is 2 gallons per square foot at design conditions. This water concentration does not change, since the volume of water and the tower area remain constant. With the water concentration at 2 gallons and the wet-bulb temperature at 60°, we adjust the angle of the straightedge on Figure 1 until we obtain a 30° differential between the hot-water and cold-water temperatures. Thus we find the hot-water temperature to be 103° and the cold-water temperature 73°.

Now suppose that 1500 gpm. flow through this tower and that the total heat load remains constant. What, then, would the cold-water temperature be when the wet-bulb temperature is 65°? The design heat load is:

$$1000 \times 8.33 \times 30 = 250{,}000 \text{ Btu. per min.}$$

The new cooling range when circulating 1500 gpm. over the tower, with the heat load remaining constant, would be:

$$\frac{250{,}000}{1500 \times 8.33} = 20^\circ$$

Theoretically, the design area of the tower according to Figure 1 is 500 square feet (1000 gpm. ÷ 2 gal. per sq. ft. = 500 sq. ft.), and the water concentration when circulating 1500 gpm. is:

$$\frac{1500}{500} = 3 \text{ gal. per sq. ft.}$$

Now, with a water concentration of 3 gallons per square foot and 65° wet-bulb temperature, adjust the straightedge on Figure 1 until there is a difference of 20° between the hot-water and cold-water temperatures. This shows the hot-water temperature to be 100° and the cold-water temperature 80°, indicating that the possibility of a lower cold-water temperature by reason of the lower wet-bulb temperature was lost because of the adverse effect of an increase in water quantity.

Figure 3 shows the type of performance curve that is furnished by the cooling-tower manufacturer. It gives the variations in performance with changes in wet-bulb and hot-water temperatures while the water quantity is kept constant.

Atmospheric Cooling Towers

In atmospheric towers, the water is pumped to the top, where it is discharged through a distributing system. As the water begins its downward flow, it is broken up and redistributed by the decks that constitute the tower filling, the air (passing horizontally through the tower) thus continually encountering newly exposed cooling surfaces. This redistribution insures even concentration of water throughout the tower during its entire fall.

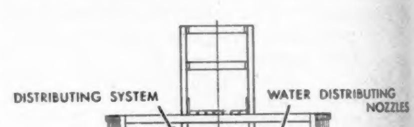
Although the initial cost of an atmospheric cooling tower (designed for a 3-mile wind) is about the same as that of a mechanical-draft tower, certain important limitations govern its performance. It must be located broadside to the prevailing wind in an exposed area. Any surrounding structures, hills, or other barriers would tend to block the wind. Originally, the main objection to atmospheric towers was the excessive spray loss during periods of high winds. This was caused by lack of a method of separating the entrained water from the air in the conventional louver-type tower. Most manufacturers have solved this problem by incorporating drift eliminators in the louvers.

The method of estimating the approximate size and performance of an atmospheric cooling tower to meet a given demand is shown in accompanying charts. The cooling capacity of any tower, with a given wet-bulb temperature and wind velocity, varies with the water concentration. Thus the problem of calculating tower size involves nothing more than determining the correct water concentration for one of a chosen height that will operate under a certain wind velocity and wet-bulb temperature. Once this water-concentration factor is known, the area of a given-height tower can be easily calculated by dividing the gallons per minute circulated by the concentration factor.

The concentration necessary to produce the desired cooling depends primarily upon the following conditions:

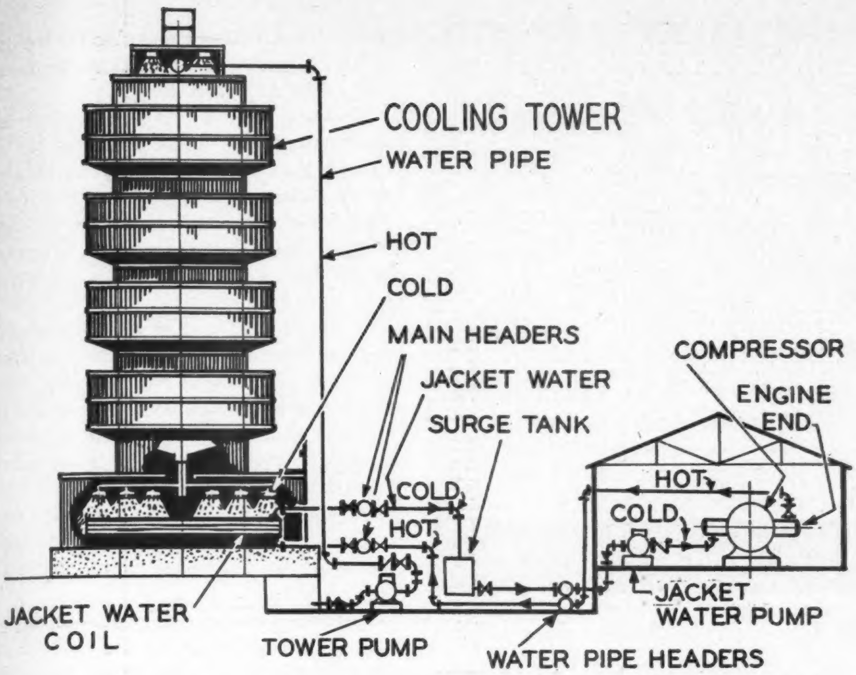
1. Temperature range ($T_1 - T_2$).
2. Approach to wet-bulb temperature ($T_2 - Twb$).
3. Tower height.
4. Wind velocity.
5. Wet-bulb temperature (Twb).

It is apparent that it is impractical if not impossible, because of the infinite number of likely combinations of these values, to have one curve from which to obtain the correct concentration factor. Figure 4 gives the required concentration for cooling water throughout a certain range and with a certain approach to the wet-bulb temperature, but this curve assumes a wet-bulb temperature of 70°, tower height of 35 feet, and a wind velocity of 3 miles an hour. Let us suppose that the conditions given are unity. Under those circumstances,



ATMOSPHERIC-TYPE TOWER

The drift eliminators on the sides separate the entrained water from the discharging air stream, thereby keeping air-borne drift loss to a minimum.



CLOSED COOLING-SYSTEM FLOW DIAGRAM

Water cooled in an atmospheric-type tower is used, in turn, to cool compressor-jacket water that is circulated through coils in the tower base.

should any of these three values change, the concentration would have to be corrected for the new conditions by using one or more of the correction factors shown in Figures 5, 6, and 7. Let us see how a variance of any of the three aforementioned conditions would affect the concentration of water.

1. Wind Velocity. The higher the wind velocity, the greater the amount of air passing through the tower. This results in greater cooling. Therefore, when the wind velocity is higher, the water concentration can also be greater and yet insure equal cooling.*

2. Tower Height. In general, in atmospheric as well as mechanical-draft towers, it is found that the greater the cooling range and the closer the approach to the wet-bulb temperature, the higher the tower will have to be to allow sufficient time of contact between water and air to accomplish the desired cooling. In atmospheric towers, the performance is limited by both maximum and minimum water concentrations. Should the water concentration fall below 1 gpm. per square foot of tower area, it will be necessary to use the next-size-higher tower. This is because the water, in extremely light water concentrations, will not be uniformly distributed and the performance, as indicated by the accompanying curves, will not be achieved. Should the water concentration exceed 3 gpm. per square foot of tower area, a tower one size lower will have to be chosen. The higher water concentrations tend to blanket the tower and will not permit enough air to pass through to effect the cooling shown by the curves.

*In deciding upon a design wind condition, it is well to bear in mind that there is a period during the day and night in which the prevailing wind shifts. When this occurs there is a short interval when there is little or no air movement. At such times the tower water temperature will rise from 2° to 5°, depending upon the duration of the calm and the design wind velocity. This should be evaluated in determining a design wind velocity. However, one should be aware of the fact that many atmospheric towers are built to operate successfully at a zero wind condition.

3. Wet-Bulb Temperature. Theoretically, a cooling tower cannot lower the temperature of the water to a point below the prevailing wet-bulb temperature. Being limited by this factor, one is more interested in the economic approach of the cold-water temperature to said temperature. Air has a greater capacity for absorbing heat at high wet-bulb temperatures. At the lower wet bulb, air, in passing through the tower, must undergo a greater temperature rise to accomplish the same cooling. Therefore, to obtain the same approach at lower wet-bulb temperatures it is necessary to reduce the concentration.

To calculate the size of an atmospheric-type cooling tower with an effective width of 12 feet, the following general formula may be used:

$$L = \frac{GPM \times W}{C \times 12 \times Cw \times Ch}$$

when:

L	=	Length of tower in ft.
GPM	=	Quantity of water in gpm.
W	=	Wind correction factor.
C	=	Concentration of water per sq. ft. of cooling-tower area.
Cw	=	Wet-bulb correction factor.
Ch	=	Tower-height correction factor.
T_1	=	Inlet temperature.
T_2	=	Outlet temperature.
$(T_1 - T_2)$	=	Temperature range.
Twb	=	Wet-bulb temperature.
$(T_2 - Twb)$	=	Approach to wet-bulb temperature.

Problem No. 1: Determine the length of a 35-foot-high tower for cooling 1500 gpm. from 90° to 75° with a 70° wet-bulb temperature and a 3-mile-per-hour wind. From these conditions we know that the approach $(T_2 - Twb) = 5°$ and the range $(T_1 - T_2) = 15°$. Consulting Figure 4 we find that these two values call for a concentration of $C = 1.17$. The correction factors, Ch, Cw, and W will be equal to one, as their respective correction-factor curves show, because Figure 4 was based upon values equal to those given in the problem. Substituting the corresponding values in the formula we determine that a tower 107 feet long is required.

Problem No. 2: Let us take the same conditions that exist in Problem No. 1 and see what the effect would be when the wind velocity is 5 miles an hour. Referring to Figure 7 we learn that $W =$

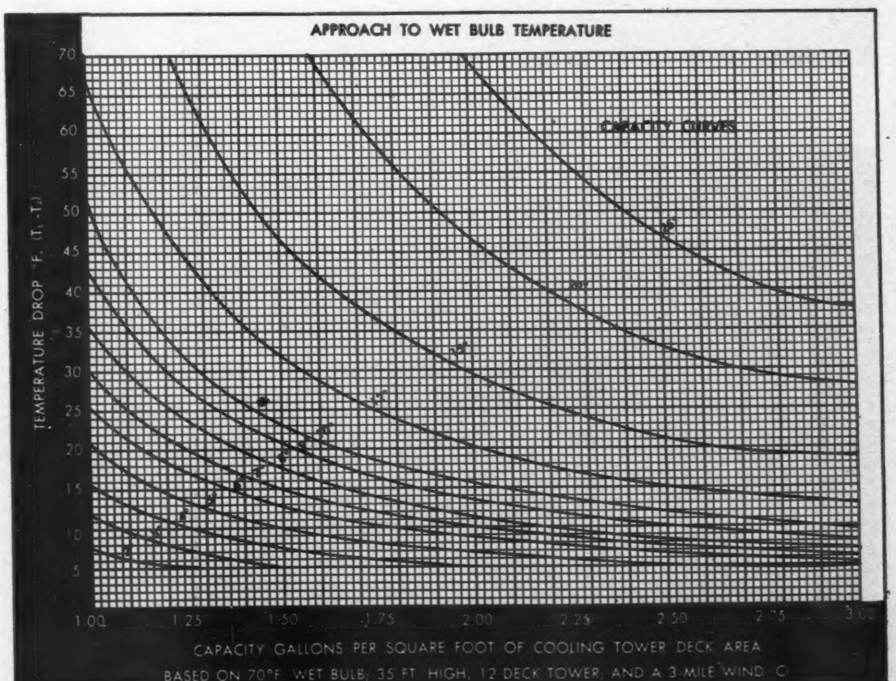


FIGURE 4

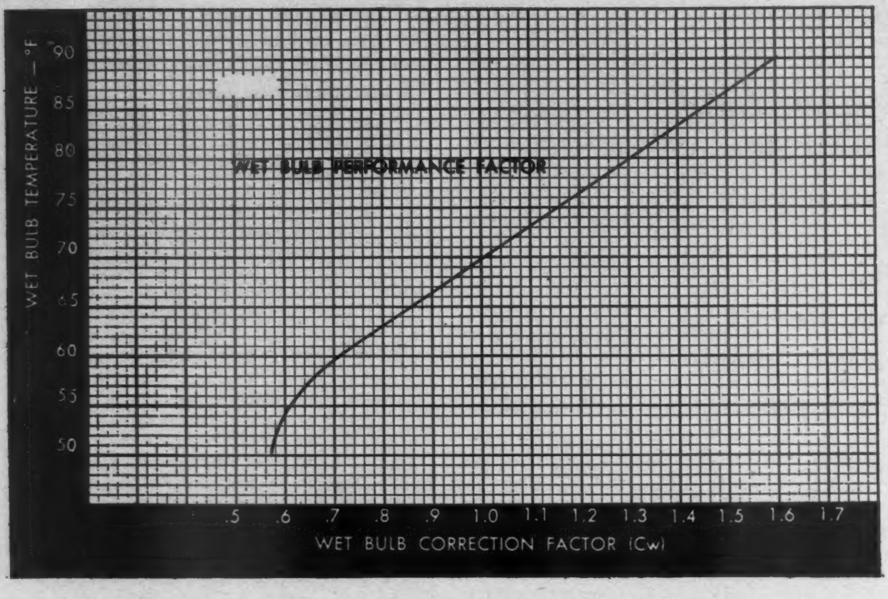


FIGURE 5

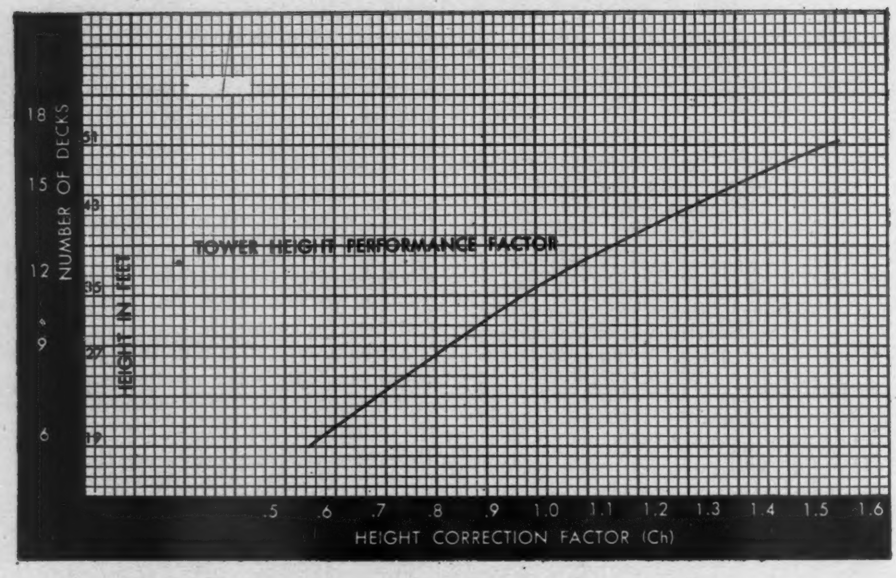


FIGURE 6

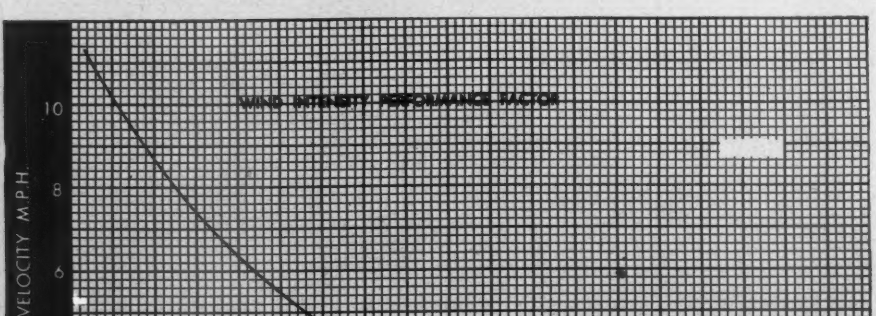


FIGURE 7

0.83. Substituting this value for the one in the formula, we find that the tower has to be 86.5 feet long.

Problem No. 3: Again assume the same conditions as in Problem No. 1, except that it is necessary because of space considerations to have a 51-foot-high tower. Figure 6 shows that Ch then = 1.63. Substituting the new Ch for that in the formula we learn that a tower 65.5 feet long is required.

Problem No. 4: Let us suppose that the conditions in this case are the same as those in Problem No. 1, except that the water has to be cooled from 85° to 70° and that the wet-bulb temperature is 65°. At that wet-bulb temperature $Cw = 0.86$, according to Figure 5. Substituting this for the corresponding factor in the general formula we find that the length of the tower would have to be 124 feet.

Problem No. 5: Once a tower is installed there often arises the problem of determining what cold-water temperature may be expected under conditions differing from those for which the tower was designed. For example, let us take the tower considered in Problem No. 1. It is 35 feet high, 12 feet wide, and 107 feet long. What cold-water temperature, T_2, can be expected when the wet-bulb temperature is 60°, the wind velocity is 4 miles an hour, the cooling range is 15°, and water is circulated at the rate of 2000 gpm?

The wet-bulb-temperature-correction factor, Cw (Figure 5), is 0.71. The wind-velocity-correction factor, W (Figure 7), is 0.875. By substituting these for the values in the general formula and solving the water concentration, we find:

$$C = \frac{2000 \times 0.875}{107 \times 12 \times 0.71 \times 1} = 1.92 \text{ gal. per sq. ft.}$$

Turning to Figure 4 we determine that, when the cooling range is 15° and the water concentration is 1.9, the approach to the wet-bulb temperature is 9.5°. This means that the cold-water temperature will be:

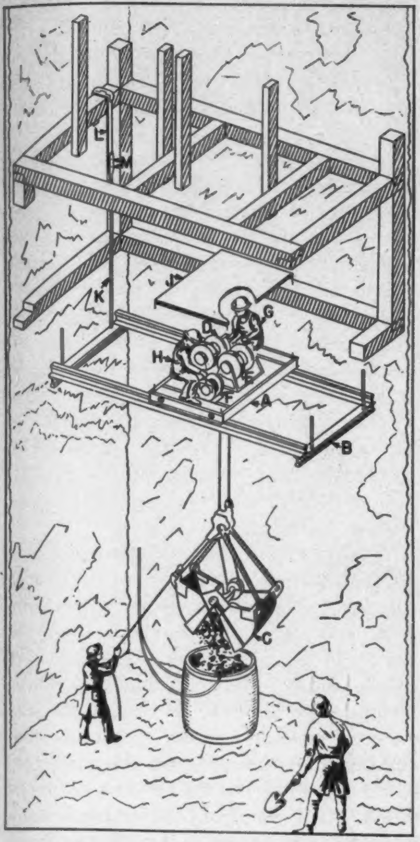
$$60° + 9.5° = 69.5°$$

The information given is presented solely for the purpose of showing the more important factors that affect the design of atmospheric-type cooling towers. Space does not allow consideration of the effect of excessive or insufficient concentration, higher relative humidity, change in wind direction, and other finer points which must be analyzed for proper cooling-tower selection. It is to be noted that the cooling-tower sizes calculated in the foregoing examples are only approximates.

This survey, while presenting the essentials, has purposely been kept as nontechnical as possible in order that it may serve as a guide to the plant operator in evaluating cooling-tower performance.

Easing the Way for the Shaft Sinker

Roy G. MacFarland



RIDDELL SHAFT MUCKER

Principal parts are a carriage, *A*, a frame, *B*, and a clamshell bucket, *C*. On the carriage are three air motors, *D*, *E*, and *F*. The first two lower and raise the bucket and the third one moves the carriage back and forth on the frame. Operator *G* handles the bucket and Operator *H* controls the movement of the carriage and transmits orders to the hoistman by signal line. They are protected by the metal cover *J*. The frame is suspended by four corner rods, *K*, bolted at *M* to hangers, *L*, that fit over shaft end sets.

BECAUSE the Coeur d'Alene Mining District in northern Idaho covers an extensive area and contains numerous operating properties, shaft-sinking of some sort is in progress there most of the time. Such work generally involves the deepening of existing shafts only 200 or 400 feet at a time and does not warrent the employment of special methods. Occasionally, however, a shaft is sunk a considerable distance, and then the operations are carefully planned to make effective use of mechanical aids and labor-saving devices. This was true in the case of the Silver Summit Shaft that was recently put down an additional 1500 feet by the Polaris Mining Company. Two principal time-saving ideas were put into joint practice with good results. One was the utilization of pneumatic columns or "air-bars" on which to mount the drifter drills for putting in blast holes. The other was the employment of an air-powered clamshell bucket for mucking.

The shaft, 18x9 feet in section, was sunk through bedded quartzite from the 1500 level to the 3000 level. The benching method was followed by dividing the bottom area into two halves, running longitudinally, and by drilling and blasting in them alternately. This tended to throw the muck into a sloping heap against the opposite end wall, thus reducing damage to the timber sets above and also simplifying the mucking operation. Under this procedure one end of the bottom area was always lower than the other one and served as a sump for collecting water. The other higher half, where the next round of drilling was done, was consequently clean and dry.

The pneumatic column was set up horizontally across the shorter dimension of the shaft, being positioned so that the complete round could be drilled without moving it. The column that was used is 3½ inches in diameter and was built locally. One end is divided into two prongs, 8 to 10 inches long. In setting it up, two Jackhamer holes were drilled in one shaft wall to receive the prongs and thus prevent the bar from turning. At the other end is a tubular air piston that is extended when air is admitted to make contact with the opposite rock face, where it is held tight by internal pressure. Admission of air is controlled by a conveniently located foot throttle, and a check valve prevents air from escaping from the column and loosening it in case the air supply is accidentally shut off.

When the bar was securely in place, three DA-35 power-feed drifter drills were mounted on it. These machines were equipped with 30-inch sliding cone shells—drill-steel centralizers for aid in collaring holes—and with automatic water-valve-type backheads that turn on water as soon as the air valve is opened. Detachable drill bits and 1⅛-inch hollow round drill rods were used. An average round consisted of 36 holes, with 8½-foot steels serving for the cut holes and back holes ranging around 6 feet deep. A period of from 2 to 2½ hours was required to drill a round, including both setting-up and tearing-down time. Two rounds increased the depth of the shaft sufficiently to permit adding a 5-foot 3-inch set of timbering.

DRILL SET-UP

This picture, taken on another property, illustrates the drill mounting. The footpiece of a pneumatic bar is shown at the extreme right in contact with the rock wall. Just above it, with a hose line attached, is the air connection to the bar. The drill pictured is a DA-30, while three DA-35 power-feed drifters were mounted on the bar in the case of the operation under discussion.

To protect the lower timber sets from the damaging effects of flying rock, a steel I-beam set, called a "battleship," was chained to the bottom of the lowest set before blasting. Following a shot, air was blown into the shaft bottom for about an hour to clear away smoke and powder gases. Fifteen minutes additional was then spent in removing rock that had become lodged in the timbering and to get the mucking mechanism ready for operation.

The mucking apparatus used is known as the "Riddell Shaft Mucker," and is patented by its originator, J. Murray Riddell, of Houghton, Mich. As shown in an accompanying sketch, it consists essentially of three principal parts: a frame, a carriage, and a clamshell bucket. The frame is a rectangular steel assembly with outside dimensions slightly less than the inside measurements of the shaft. This permits placing it within the timbered section of a shaft, or be-

MINING METROPOLIS

Wallace, Idaho, one of the trading centers of the Coeur d'Alene Mining District is the site of the country's leading silver mine and the second largest producer of lead. It also has a substantial zinc output. There is more shaft-sinking activity there now than in any other mining area in the nation.

neath it. The frame is made of 112-pound steel rail members. It is suspended from rods attached to each corner and bolted at their upper ends to U-shaped hangers that straddle the end pieces of opposing shaft timber sets. The carriage, a structural-steel chassis with flanged wheels at each corner, engages the frame upon which it moves horizontally along the long axis of the shaft. Guard rails are provided to prevent derailment. The opposed wheels at one end are keyed to a common connecting shaft to which there is also keyed a chain sprocket wheel. The two other wheels have separate stub shafts.

Three compressed-air motors are mounted on the carriage. Two of them furnish power for operating a clamshell bucket, one serving the digging line and the other the hoisting line. The third motor, which is of the reversible type, is geared to the sprockets on one set of wheels and propels the carriage in either direction. The air for these units is supplied through a 1½-inch hose attached to the line that serves the shaft. At the carriage, it enters a header and, after passing through an air-line lubricator, is fed to the motors through suitable piping.

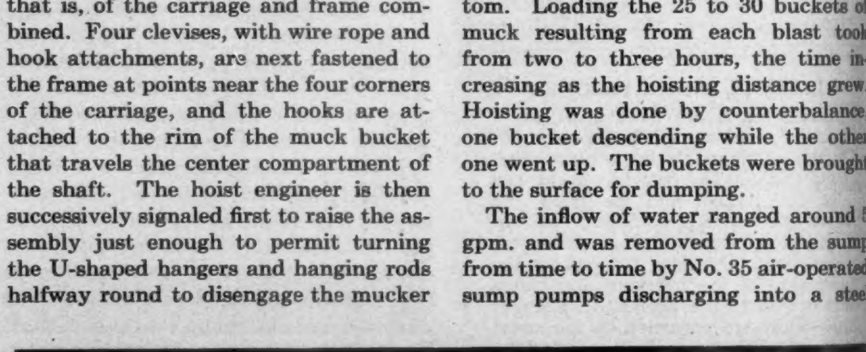
Two men ride the carriage: one to operate the clamshell and the other to move the carriage back and forth, as required. At times, the latter transmits orders to the hoisting engineer by means of a bell signal line; at others, this is done by one of the workers on the shaft bottom. A light metal roof over the entire carriage protects its crew from falling objects and water.

As the shaft is deepened, the carriage is progressively lowered to a new position by the following procedure: The clamshell is moved to the shaft bottom and the carriage is positioned and locked at the center of gravity of the mucker—that is, of the carriage and frame combined. Four clevises, with wire rope and hook attachments, are next fastened to the frame at points near the four corners of the carriage, and the hooks are attached to the rim of the muck bucket that travels the center compartment of the shaft. The hoist engineer is then successively signaled first to raise the assembly just enough to permit turning the U-shaped hangers and hanging rods halfway round to disengage the mucker from its support and, next, to bring the frame and carriage down to a level approximately 1 foot above the new working station. There the hangers are turned back to their original position so that, after lowering the assembly to the desired level, they will again straddle horizontal members of the shaft timber sets.

A 5-foot length of 6x10-inch timber is placed across the tops of the hangers at each end of the mucker and is securely chained to the end pieces of the shaft set on which the hangers rest. This eliminates the possibility of the force of a blast disengaging the hangers and lifting the assembly. The frame is also attached by chains to opposed end pieces of the shaft set to prevent it from falling in case a hanging rod should break during operations. Moving the mucking apparatus from one position to another as just described can be effected in about twelve minutes.

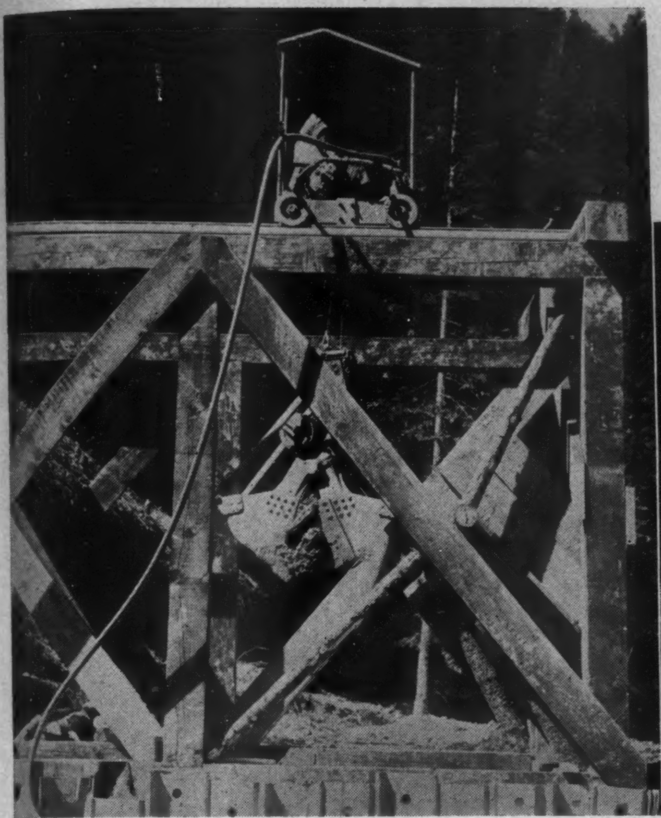
On the Silver Summit Shaft job, the clamshell bucket used was of the "hard-digging" Blaw-Knox type with front, side, and corner teeth and with a capacity of ⅜ cubic yard. This unit is 20 inches wide, 6 feet long when open, and weighs 2020 pounds. It discharged into a conventional round, 32-cubic-foot sinking bucket resting on the shaft bottom. Loading the 25 to 30 buckets of muck resulting from each blast took from two to three hours, the time increasing as the hoisting distance grew. Hoisting was done by counterbalance, one bucket descending while the other one went up. The buckets were brought to the surface for dumping.

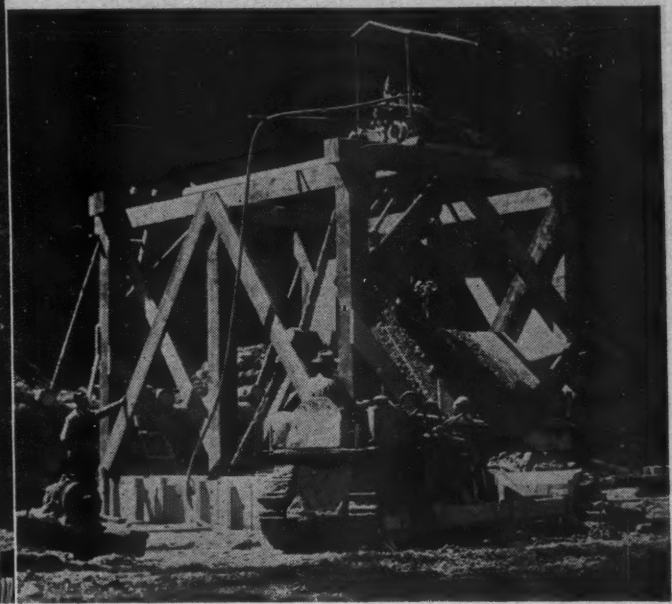
The inflow of water ranged around 5 gpm. and was removed from the sump from time to time by No. 35 air-operated sump pumps discharging into a steel



POLARIS MILL

This plant will treat ore from the Silver Summit Shaft, the head of which is up the hill and to the left.





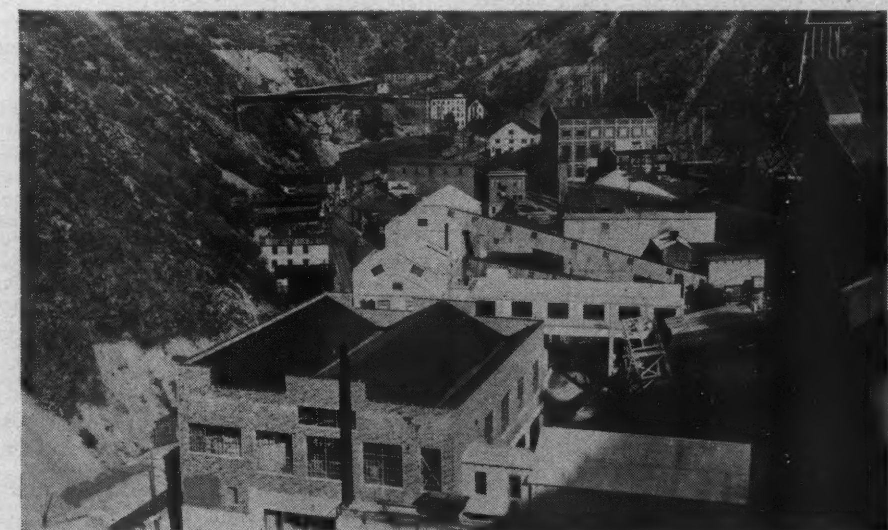
SHAFT MUCKER IN ACTION
Here are two views of the Riddell apparatus starting the new Rock Creek Shaft of the Hecla Mining Company. This is a later-type machine than the one described in the accompanying article and is arranged to be operated by one man instead of two. The picture at the left shows the clamshell bucket. It dumps the muck down a slide at the right, after which the bulldozer, below, spreads the material over the dump area.

tank located in the pipe-column compartment of the shaft. From the tank it was elevated to the next pump, or the next station level, as the case might be, by a 20-hp. 2-stage Motorpump with a float-control arrangement for starting and stopping. Six-stage Cameron centrifugal pumps of 200-gpm. capacity under 1500 feet of head will be permanently installed to handle the water. Ventilating air was sent down the shaft through a 22-inch, light metal pipe assembled in sections having flanged ends.

Stations were cut every 500 feet to provide space temporarily for electrical equipment, pumps, drill steel, and miscellaneous equipment. In advancing these stations as a part of the mining-development operations, excavating is being done with scrapers powered by A5NN-0H air hoists. Shaft sinking was started on February 1, 1946, and completed on December 9, 1946. Work was carried on in three shifts, seven days a week, with rotation of the shifts every two weeks. A shift crew consisted of four men and a boss, and the entire operation was in charge of a shaft foreman.

Shaft sinking as traditionally carried on by hand shoveling is unquestionably one of the most back-breaking jobs in mining. As a consequence, every effort has been made through the years to find ways of lessening the heavy physical labor involved, and the equipment that has been described is the latest thing along that line in our western mining regions. When the shaft mucker was first put in service, the miners were openly skeptical of its worth, but they soon became enthusiastic boosters. This is proved by the fact that there was actually a waiting list for jobs in this instance, even though it is ordinarily difficult to keep a shaft-sinking force up to strength and only about half as many men as were needed was available in the Coeur d'Alene District as a whole. Miners who habitually work at shaft sinking have estimated that it has reduced the expenditure of physical effort by as much as 50 percent.

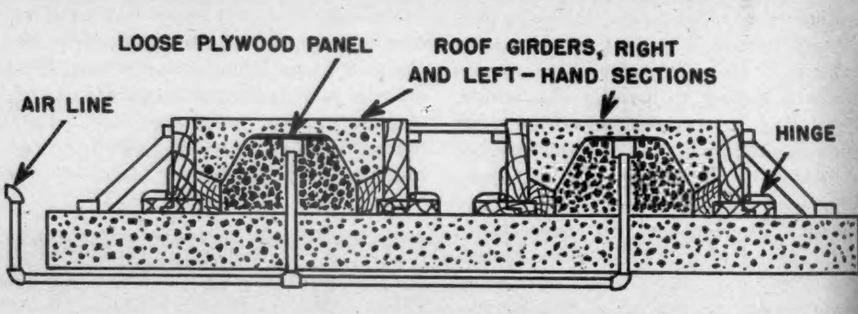
The over-all efficiency of the procedure is also borne out by the progress figures. In the month of July, last year, 183¾ linear feet of shaft was sunk and 35 sets of timber placed. This represented a new record for the district; but it was bettered considerably in September by sinking 204¾ feet and placing 39 timber sets. As a result of the success achieved by the means and methods described here they will be used soon on three additional shaft-sinking jobs in the Coeur d'Alene District.



CLOSE QUARTERS
These workings comfortably fill the bottom of a gulch near Burke. At the right is the Hecla Shaft, which is the outlet for zinc-lead ore from the Star Mine. The latter is owned by the Sullivan Mining Company, which is controlled jointly by Hecla and Bunker Hill. The Star Mill is at the lower left.

New Means of Precasting Concrete

Anna M. Hoffmann



MOLDS FOR 2-PIECE MEMBERS

Section of the precasting yard at the U.S. Naval Supply Depot (left), Mechanicsburg, Pa. The cores of the molds are of hard, smooth, and oiled concrete, with side walls of plywood hinged at the bottom to facilitate stripping. Vertical slots provide for increased thickness of material at points where girder halves are joined by through bolts, and transverse recesses form stiffening diaphragms. At the right are shown the mating parts of a form for an exterior cantilever column. Concrete is being poured direct from a 3-cubic-yard truck mixer and compacted by vibrating the wire-mesh reinforcing with an air-operated chipping hammer. After pouring, the molds were covered with vacuum mats to hasten curing. The cross-sectional drawing gives details of typical forms for casting a 2-piece structural member.

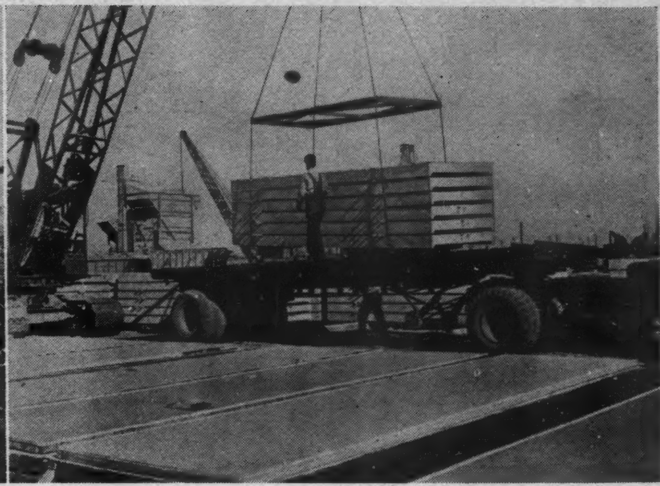
IN VIEW of the present housing situation, any technique that promises to shorten building time and effect economies without sacrificing structural soundness is a step of interest not only to the man who wants a new house but also to the contractor. Such a step has been taken by Vacuum Concrete, Inc., in the development of means and methods of precasting and erecting concrete members that, compared with general practices, would seem to forecast speedier construction as well as savings in materials through reductions in weight.

To determine the practicability of the company's Vacuum Concrete Precast System, A. Amirikian, Designing Engineer of the U. S. Bureau of Yards and Docks of the Navy Department, laid out two single-story warehouses with framing made up entirely of elements produced by the new method. Each is 600x200 feet in plan and has a loading platform with a 16-foot-wide canopy on one side. They have been built at the Naval Supply Depot, Mechanicsburg, Pa., by the Corbetta Construction Company and, despite the experimental nature of the work, the first was completed in 40 days and the second, when the men had become familiar with the technique, in eighteen days.

Foundations and floors, and walls of concrete blocks are of the customary type; but the roof panels, columns, girders, and struts were precast by the vacuum system and assembled by welding and concreting. The roof slabs, like the inside columns and struts, were made in one piece, while exterior columns, T-caps for the interior columns, and girders were cast in two pieces that were bolted together before erection to form hollow, lightweight box members stiffened by interior diaphragms.

Some 4000 structural units were required for the framing of the warehouses, and these were produced on the site by the use of 100 or so special molds. With the exception of those for the 1-piece columns and struts, which were poured around treated cardboard tubing, the forms consisted of a core of hard, smoothly troweled, oiled concrete and of plywood side walls that were hinged at the bottom so they could be laid flat to facilitate stripping and reassembly. The reinforcing was of 2-inch wire mesh that was made trough-shaped by a job-built press operated with compressed air. Before placing in the molds, it was wired to steel rods by which abutting sections were tied together.

Concrete for precasting was delivered from a central batching plant in 3-cubic-yard truck mixers and was composed of high, early-strength cement (8 to 9 bags per cubic yard of concrete), with pea gravel and stone screening as aggregates. This mix, together with the use of

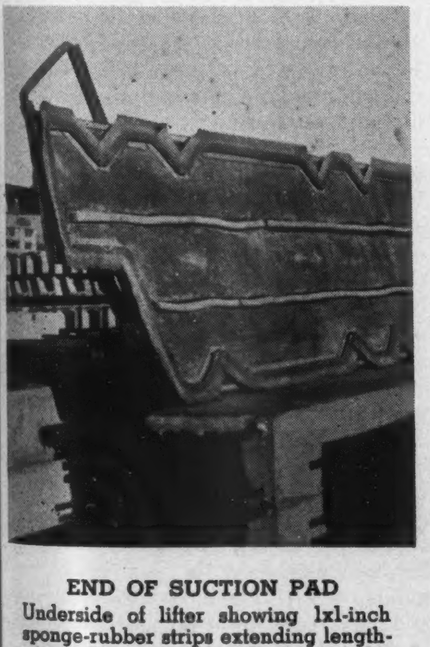


HOW SUCTION PAD WORKS

When a mold is ready for stripping, a lifter of the same shape and size is laid on top of it and a flexible hose, tapping a suction line, is attached to a pipe projecting from the back of the pad. What happens when vacuum is induced and a crane begins to hoist the load is pictured at the left. In this case, half of a box girder is seen clinging to the suction pad, which also serves to stiffen the green-concrete structural member and thus eliminates bending stresses during transfer. At the right are roof slabs for the Naval Depot warehouses. The panels in the foreground were photographed immediately after removal of the vacuum mats that are used to extract excess moisture from the concrete to shorten the curing period. Molds were stripped by the suction-pad method the day after pouring. Picture also shows how slabs were stacked and loaded on a trailer for transportation to the building site.

vacuum mats laid on top of the forms to extract excess water, made it possible, it is claimed, to turn out concrete members with a compressive strength of more than 2500 psi. in less than 20 hours each, or at the rate of one a day per mold.

Perhaps the most ingenious feature of the new method is the suction pad or vacuum lifter by which the long, heavy pieces of green concrete are stripped from the molds without danger of distortion. This pad is made of plywood set in a structural-steel frame and is provided on the underside with strips of soft rubber, two in the center running lengthwise and one around the edges. Fitting snugly on a mold, the lifter functions like a magnet, except that vacuum is applied instead of electricity. On the job in question, it was handled by a crawler crane and, when properly positioned, was connected by a length of flexible hose to the yard's extensive suction-piping system.



END OF SUCTION PAD

Underside of lifter showing 1x1-inch sponge-rubber strips extending lengthwise and around edges. A rubber seal is cemented over outer strip, and notches fit around sleeves or openings.

It was found that vacuum of approximately 12½ inches of mercury was sufficient to cause the pad to grip a casting firmly and to hold it while the crane deposited it near by for curing. However, before removal could be effected, it was necessary to break the "normal suction" between the concrete mold and the structural member by admitting compressed air through openings left in the core for that purpose.

Actual construction proceeded somewhat along the lines followed in putting up a steel building. Each hollow column was securely anchored to the floor by reinforcing rods projecting from the latter and by concrete which was introduced through a bottom access hole in the column with the help of a plywood chute. As previously mentioned, interior columns were cast in one piece around cardboard tubing. This remained in place except at the ends where the inner surfaces were sandblasted to insure a firm bond with freshly placed concrete.

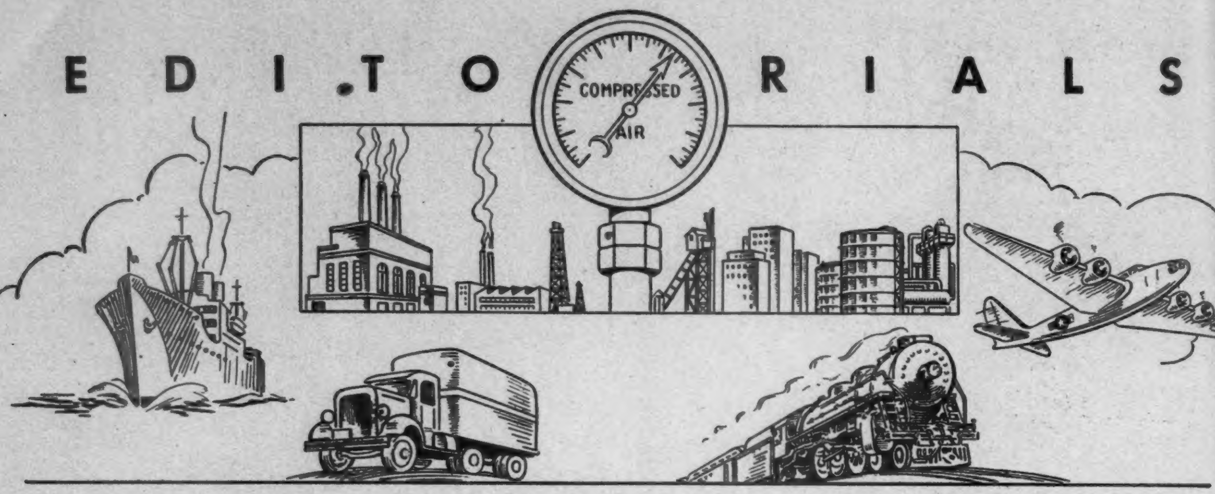
Struts, girders, and T-caps were similarly connected to the columns, the protruding reinforcing being embedded in concrete poured through openings in the joint pockets into which the rods extended. But before this was done, abutting box-girder and cap reinforcing rods were welded together. Columns were held upright during erection by braces provided with turnbuckles to facilitate positioning, and tubular steel scaffolding was used to support the horizontal sections until they had become a part of the monolithic structure.

The work was done in ordered sequence, roofing following closely upon assembly of the framing. The roof slabs are 20 feet long, 5 feet wide, and ¼ inch thick, and have integral longitudinal beams and transverse ribs. Preparatory to casting, steel inserts were welded to the panels' main reinforcing, and these inserts, in turn, were welded to steel straps bolted to the faces of the girders. The roof slabs were thus quickly put in place, and the entire surface was then covered with a built-up felt-and-asphalt membrane.

Precast-concrete structural materials are nothing new, but the use of high, early-strength cement, together with vacuum mats to hasten curing and suction pads that permit lifting members from the molds while still green, makes for what comes close to being mass production. According to A. Amirikian, "The successful completion of the warehouses has demonstrated the merit of precast concrete construction, and the new technique will no doubt play an important role in future building construction, especially in the industrial field."

Many other units besides those mentioned can be made by the new process, which is at present being used to supply floor slabs for the United Nations Housing Project at Jamaica, Long Island, and by a Philadelphia contractor to provide much needed homes.

EDITORIALS



PROTECTIVE ENGINEERING

THE War Department recently reported that it is sponsoring an intensive study of the problems connected with placing essential industrial plants underground. The information gathered will obviously be put to use in the event another war envelopes the globe. As a part of the investigation, Guy B. Panero, head of a civilian consulting engineering firm, is conducting a $150,000 survey of subterranean factory sites. He has already catalogued existing mines that might be adapted for the purpose, and the present work concerns the location of new and supplementary sites. As background training for his search, Mr. Panero visited underground manufacturing establishments in Sweden, Germany, and France, some of which were operated as long ago as 1936.

The building of subsurface factories will pose various unusual technical problems, according to Mr. Panero, and create a new branch of engineering, which the War Department has already named protective engineering. Men skilled in mining and tunneling operations will naturally be in demand as directors and consultants, should need to start digging actually arise. And, manifestly, the rock drill will become a leading tool of defense in the new tactics, supplementing the important work it has always done in speeding the extraction of vital metals from the earth.

This movement of war plants underground writes another chapter in the evolution of mankind—a chapter that might be called completing the circle. Before *homo sapiens* knew how to build houses he lived in caves that he gouged out of soft rock with the meager implements he possessed. Then came education. Apparently, a little knowledge is, indeed, a dangerous thing, for man learned to create more deadly weapons than nature had given him and he used them to wage organized warfare. Then he conceived explosives and internal-combustion engines and soon mastered the art of flying, which made it possible for him to deal death at great range.

Finally, he cracked the secret of harnessing atomic energy and thus multiplied his capacity for terrifying and destroying those with whom he might go to war. Since there is as yet no known way of escaping the lethal effects of these modern sky-borne missiles while remaining above ground, it is the better part of discretion to start burrowing, and that is evidently what mankind intends to do. Civilization, it seems, is leading us right back to where we started and may yet make us human wombats and moles.

INDUSTRIAL EQUIPMENT PRICES

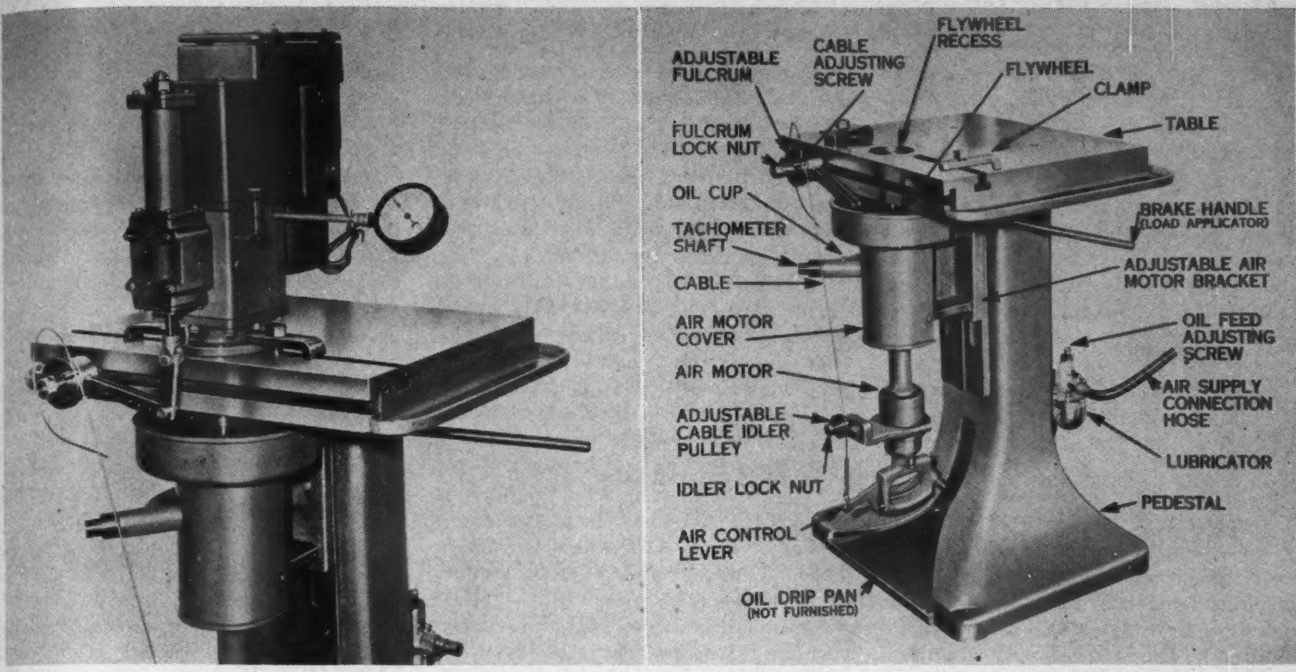
ALTHOUGH there has been an alarming over-all rise in prices that has clouded the nation's economic outlook and elicited expressions of concern from business leaders and even from President Truman, relatively little blame for the difficult situation that confronts us can be laid on the doorstep of manufacturers of industrial machinery. On the contrary, figures released by the Machinery & Allied Products Institute indicate that builders of heavy machinery have compiled a remarkable record in keeping their selling costs reasonably well in line with 1939 levels.

A chart of wholesale prices and construction costs prepared by MAPI shows that the all-commodity index of prices rose 94 percent between 1939 and April of this year. Raw materials were up 133 percent, manufactured products 79 percent, and construction 102 percent. By contrast, industrial-equipment costs increased only 28 percent. It is true that machinery prices were pegged by government edict during the war period, and a good part of their rise came after controls were removed last year. Nevertheless, the increase has been materially less than in the cases of the other indexes cited, and this moderation reflects admirable restraint by the collective managements responsible.

Advances in quotations have been kept moderate despite the fact that the industry has had to absorb an average boost of 73 percent in straight-time hourly wage rates and one of 40-50 percent in the price of purchased materials. This accomplishment is attributable partly to economies resulting from volume production and from improved mechanization of manufacturing processes. In addition, the industry has taken a reduction in profits, as is evidenced by a compilation made by the National City Bank of New York. These figures indicate that 97 manufacturers reported average net returns of 5.9 percent in 1946, compared with 11.2 percent in 1936, with 9.1 percent in 1937, with 9.8 percent in 1940, and 8.8 percent in 1941.

The industrial-equipment index used in arriving at the average price increase of 28 percent was based on the average figures for sixteen types or groups of machinery manufacturers. Included in the list were builders of air compressors, fans and blowers, and power-driven pumps. The indexes for the separate groups were prepared by the Bureau of Labor Statistics, as were those for all commodities, raw materials, and manufactured products.

As is pointed out by MAPI, this moderate rise in machinery costs promises to influence the trend of our economy. With the average wage rate in manufacturing plants 75 percent higher than it was in 1939, machinery is relatively much more economical than labor, and the tendency therefore is towards greater mechanization. If the relationship of wages and equipment prices is maintained at anywhere near its present ratio, that will unquestionably stimulate large-scale modernization programs in manufacturing industries. This will not only benefit equipment makers for some time to come but, by increasing production efficiency in manufacturing plants, will also reduce product prices and contribute towards the stabilization of our entire national economy by placing it on a more favorable level than the existing one.



GOVERNOR MOUNTED FOR TEST RUN

The air motor that drives the governor is an Ingersoll-Rand unit of the 3G Multi-Vane Type and is mounted in the casing below the table (left) for direct connection with the governor shaft. It is lubricated by an automatic Norgren oiler with adjustable drop feed. Air at from 80 to 100 psi. is used to operate the motor and is kept constant by a pressure regulator interposed in the supply line that is attached at the bottom-right. Two clamps hold the governor firmly in place during testing. The other picture shows the fully equipped stand with the air-motor valve and adjustable fulcrum linked by the cable that is flexed to start the motor. This operation is continued until the governor takes over.

Stand Built to Test Governors Under Service Conditions

GOVERNORS for diesel engines must be built with accuracy to perform the important function for which they are designed. These units control the amount of fuel injected into the engine cylinders by the fuel pumps and come into action as soon as the engine overspeeds or underspeeds. In many cases where diesels drive equipment such as electric generators, governors must be extremely sensitive to slight changes in engine speed, and it is for this reason that they have to undergo rigid testing and minute adjustment under simulated running conditions before they leave the factory. This applies not to one unit picked at random from a lot but to each one, and has led the Woodward Governor Company to design and construct a test stand that does this work not only in routine fashion but also with precision.

The stand consists of a cast-iron surface plate and pedestal and is equipped with an air motor of the Multi-Vane Type that has a speed range from 150 rpm. to 4200 rpm. This unit drives the governor which, in turn, controls the speed of the motor by throttling the air supply. Air at from 80 to 100 psi. is used, and the pressure must be kept constant close to the stand for satisfactory testing.

Different types of governors can be coupled to the motor by means of a mounting plate and drive-shaft adapters, of which three are standard equipment. Depending upon whether it is keyed or serrated, the adapter is either attached to the governor drive shaft or dropped into a flywheel recess in the table top. The shaft is then inserted in the recess until the governor rests squarely upon the flat surface plate, something that is necessary for smooth running. It may also involve moving the motor up or down in order to get it in proper position to drive the shaft.

After the governor has been filled with oil to a predetermined level and been linked with an adjustable fulcrum on the stand, the air motor is started. This is done by flexing the cable that connects the fulcrum and the air-control lever until the governor takes over. Testing involves dispelling all air bubbles by allowing governor to surge for about five minutes, warming the oil by letting the unit run from 15 to 20 minutes, adjusting the compensating needle valve, and checking the response of the governor under its specified high and low speeds and under other service conditions. Excessive heating, vibration, oil leakage, and defective parts can be detected by the stand operator, and different measuring and indicating instruments enable him to make the corrections and adjustments necessary to insure a governor that will do the exacting work for which it is designed.

INDUSTRIAL HEATING PAD

This is a 187-pound, 30-foot-long electric heating blanket that was developed by Goodyear Tire & Rubber Company for drying multicolored inks used in the fabric-printing industry. A rubber sheet that conducts electricity is sandwiched between two nonconductive sheets. Heat can be maintained at any degree between room temperature and 170°F. Among the many suggested applications for such laminates is their employment under the lids of a quick-freeze unit to thaw the ice bond so they can be opened readily.

Portable-Air-Compressor Lubrication

THE May issue of The Texas Company's technical publication *Lubrication* is devoted to a discussion of the lubrication of the portable air compressor, a machine that it refers to as producing the "breath of life" for building, highway work, and railway-track maintenance. Attention is drawn to the portable's sturdy construction and its dependability under all weather conditions, factors of importance to the contractor or other user who relies upon it to keep his air-driven tools working. It is pointed out that, inasmuch as the portable often operates in remote areas, its lubrication system has to be designed to function with a minimum of trouble. Lubrication of both the gasoline or oil-engine driver and the compressor itself must be considered, and the article deals with them separately. Regarding compressor lubrication it states:

"The service load has a lot to do with lubrication. The oil must be capable of meeting the most severe conditions, even though the machine may not impose these conditions at all times. To be sure of this, the operator must consider the adaptability of available compressor oils to his particular service and the lubrication systems in the machines he is operating. Conditions which can affect the performance of an air compressor oil and have a bearing on the selection of the type of oil, involve the temperatures and pressures encountered, the amount of condensation occurring, and the metals used."

All these points are discussed in detail, and similar attention is given to the factors that govern the lubricating needs of both gasoline and oil-engine drivers. In summing up, it is stated that "Careful attention to the selection and application of good-quality lubricants in the correct viscosity grades is the best insurance of low operating and maintenance cost."

The complete article may be had upon request from The Texas Company, 135 East Forty-second Street, New York 17, N. Y.

Air-Bored Holes Obviate Trenching

PRODUCTION of three new models of its air-operated horizontal earth-boring machine, which is used to make openings for pipes underneath streets, highways, railways, etc., has been announced by the Hydrauger Corporation, Ltd., at 116 Montgomery Street, San Francisco, Calif. The largest of the outfits, Model 10-A, is powered by an air motor that develops 5.2 hp. at a pressure of 90 psi. It is capable of boring a 2½-inch-diameter hole a distance of 200 feet, and this opening can be enlarged to a diameter of 14½ inches by reaming. Stripped for lowering into a trench from which the work is conducted, the machine weighs 350 pounds. It requires two men to operate it. The Model L-2 is a 3.2-hp. unit that bores a 2-inch hole a distance of 100 feet and reams it to a diameter of 4½ inches. Its stripped weight is 110 pounds, and one man can operate it. A hand-held adaptation of Model L-2 weighs 35 pounds. It is designed to make holes for lateral piping up to 50 feet long.

Holes can be bored with Hydraugers without disturbing the ground surface and thus interfering with street traffic or any other use to which the area is ordinarily put. The method promotes safety and is claimed to be much more economical than trenching. Boring speed for an 8½-inch reamed hole varies from 4 feet per hour in solid limestone to as much as 40 feet in ordinary soft soils. Cuttings are removed from the hole by water, the consumption of which ranges from 3 to 20 gpm. Where a piped supply is not available, an air-driven circulating pump is usually utilized. Air for operating the latter and the boring machine is generally furnished by a small portable compressor.

HYDRAUGER IN OPERATION
The largest of the three sizes, with reamer attached. This unit is driven by a 5.2-hp. air motor. It can bore a 2½-inch hole 200 feet and enlarge it to 14½ inches.

Carbon-Monoxide Detector

LETHAL concentrations of carbon monoxide in the atmosphere cannot be detected without the help of an instrument because the gas is colorless and odorless and strikes its victims unawares. Various types of detectors have been developed for use in mines and industrial establishments, but it was not until the war that the National Bureau of Standards produced a small, inexpensive device that even an inexperienced person can handle.

About the size of a pencil, the indicator consists of a sealed glass tube containing a yellow chemical and of a rubber bulb, all packed in a pocket-size kit. To test the atmosphere, one end of the tube, from which the tip has been broken, is inserted into the bulb. Pressure on the latter draws samples of air through the gel, which will turn green in 30 seconds if carbon monoxide is present. The darker the shade, the higher the concentration, which can be determined by comparing the color of the chemical with a color chart. It is claimed that the instrument will detect and closely estimate less than 1 part of carbon monoxide in 500 million parts of air, thus allowing a big factor of safety because it takes about 1 in 10,000 to affect the human system.

In addition to its use in army tanks and airplanes, for which the detector was designed, it will have a wide field of application in refineries, cabins of gasoline-propelled boats, busses, cabs of trucks, automobile repair shops, homes, in fact, anywhere where carbon monoxide presents a hazard. The United States Safety Service Company, Kansas City, Mo., has been licensed to manufacture the instrument and the chemical.

Industrial Notes

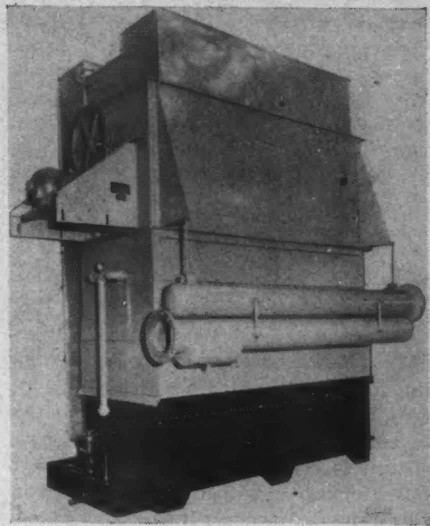
For the heat treatment of materials that are highly reactive towards gases, a new type of high-vacuum furnace has been developed by Eitel-McCullough, Inc. Capable of continuous operation at temperatures in the 1800°C. (3272°F.) region, the standard unit consists of three chambers in one cubicle, as illustrated. Each chamber is equipped with a special high-speed oil diffusion pump,

and heat is furnished by large-diameter tungsten elements which involve low voltages, thus minimizing ionization problems. Cycling circuits are incorporated so that one chamber can be in the treatment phase while another is under preliminary pumping and third is being reloaded. Timers control the operating cycle, the frequency of which depends upon the nature and the amount of material undergoing treatment. The latter is ordinarily placed in molybdenum containers, which are inserted into the chambers to expedite processing, and where a wide variety of work is handled, separate containers can be used for each type of treatment to lessen chance of one contaminating another. Interlocking safety devices are provided to protect furnace parts against temperature extremes and heating filaments against burnout from operation at too high a gas pressure. The 3-chamber unit has a total treating capacity of 175 cubic inches, and it is claimed that the furnace makes it possible for the first time to attain a production vacuum as high as 0.000005 millimeters of mercury.

In our September, 1941, issue we described what are known as Rotary Pipe Crawlers—rubber balls encased in chain mesh that snaps on and off. The crawler is inflated with compressed air after it has been introduced in a main and scours the surface as it is carried along under the impulse of the fluid flowing through it. Modifications in pipe-laying procedure have necessitated an addition to the line, a ball for 10- and 12-inch pipes in which weld spatter or similar sharp obstructions may puncture the rubber and impair a crawler's usefulness. To obviate this, the new type is given a fabric covering to strengthen it and is surrounded by a double-chain meshwork. Standard line of balls embraces sizes for pipes ranging in diameter from 2 to 36 inches, and units may be purchased or obtained on a rental basis.

Electric current takes the path of least resistance, and it is upon this theory that Darin & Armstrong, Detroit contractors, have developed safety air hose for pneumatic drills and concrete breakers. It consists of a spiral of 832 braided strands of No. 30 bare copper wire embedded in Neoprene—synthetic rubber—and by-passes current around an operator should his tool strike an underground high-tension line. When properly grounded, hose is said to have resistance of less than 0.06 ohm, as against 200-1000 for the human body. When drill point comes in contact with a wire, current shorts through hose, even when worker is standing on damp ground. When used in connection with a plant's air lines, grounding is automatically taken care of, but ground must be provided if air is supplied by a portable compressor. Hose is being manufactured by the Mercer Rubber Company.

For cooling compressed air and condensing and removing the contained water vapor, Niagara Blower Company has announced an improved type of Aero After Cooler that is based on the principle of evaporative cooling. This



is effected by passing the compressed air through coils in a spray chamber through which atmospheric air is drawn by fans to evaporate some of the recirculating spray water. Heat at the rate of 1000 Btu. per pound of water evaporated is thus extracted from the compressed air. The water is handled by a motor-driven immersion pump of the Ingersoll-Rand type. In the new equipment the compressed-air coils are arranged laterally in the spray chamber and the compressed air is introduced by way of an oversize manifold disposed lengthwise and on the outside of the aftercooler housing. It is withdrawn and delivered to a receiver by means of a similar manifold. As a

A BREEZE FOR OLD GLORY

A compressor-manufacturing company that entered a float in a community parade was faced with the problem of showing in some simple way that the machine on the truck actually was compressing air. This was done by mounting an American flag at the rear of the float, using as a staff a piece of pipe with perforations in the upper end. The compressor discharge was connected to the pipe, and the exhaust air escaping from the holes kept the flag flying.

result of the changes in design, the friction of the compressed air in its passage through the coils is reduced and there is greater contact between the coils and the evaporating spray, thereby bringing the temperature of the compressed air closer to the wet-bulb temperature of the atmospheric air. Inasmuch as the compressed-air temperature reached is always lower than the dry-bulb temperature of the ambient air, condensation of water in air lines and tools is prevented.

Aluminum and its alloys is given the appearance of brass or chrome by an electrochemical process announced by Colonial Alloys Company. Not a plating, or a painted, lacquered, or dyed film, the finish is the result of a change in surface that is said to be highly resistant to corrosion and abrasion and to have reflective properties like a mirror. Polishing is unnecessary, and an occasional washing with a mild soap solution is all the maintenance that is required.

What appears to be a simple method of eliminating static is offered by the Canadian Radium & Uranium Corporation. That concern is plating metal strips with radioactive polonium, which is said to have an ionization effect about 1000 times that of an equivalent weight of radium. It is this effect that dissipates the static. As the material emits pure alpha rays—no beta or gamma rays—shields for the protection of the workers are not required. Strips must be renewed occasionally, and the company maintains a replacement service on a fee basis.

Automobile tires build up static electricity as they move along, and most motorists are probably aware of this fact because of shocks sustained and poor radio reception. Static so induced can be eliminated, we are informed, by a powder that is the outcome of research on conductive rubber tires for industrial trucks and tractors. About a tablespoonful of the pulverized material is injected by an air hose and special container into each inner tube after deflation and removal of the core. Powder is to be distributed soon through U. S. Rubber dealers of Fisk & Gillette tires.

Something unique in the way of a covering for plating baths to minimize spray loss of chromium acid has been conceived by Udylite Corporation. A multiple of Styron plastic tubes, 3/8 inch in diameter, 2 1/2 inches long, and sealed at both ends, are floated on the solution, forming a blanket that does not interfere with immersion or withdrawal of the work. Plastic is shatterproof. About 1 1/2 pounds of tubes, known as Chrome-Lock, cover a square foot of surface. Advantages claimed for the blanket are reduction in heat input, a 50 to 75 percent saving in acid loss, and protection for the workers.

Mead Specialties Company has in production a new 3-way valve for fast-acting air cylinders of 4-inch bore and more. It is designed for cam operation or, with a lever and bracket, for fingertip control. The button is positioned low so operator can rest wrist on work bench and has a full travel of but 1/8 inch. Units can be attached either to vertical or horizontal surfaces and, if connected in series as illustrated and far enough apart, prevent accidents because both the worker's hands are needed to run a machine. Four models are available: FT-1, for pneumatic presses, impact hammers, etc., is normally closed. It actuates cylinder when

button is pressed and exhausts when button is released; FT-2, normally open, functions in reverse order and is used with holding fixtures such as collets, vises, and work feeders. FC-1 and FC-2 serve the same purposes, respectively, but are cam controlled. All have two paralleling connections for hose of 1/4-inch inside diameter.

Sudbury Laboratory has announced that its Aqua-Clear, a colorless liquid, is now available for general industrial application. Put in water, it deposits on metal surfaces a thin nonpermanent film that is maintained by adding small quantities from time to time. The solution was developed to prevent the corrosion of water storage tanks on shipboard and is said to have no effect on drinking water.

Small nonmetallic articles can be made suitable for plating by spraying them with a mixture of silver nitrate and reducer solutions. To do this work, the Monomelt Company has designed a stainless-steel booth with a hand-operated turntable on a ball-and-socket mounting that permits tilting, a window to protect the worker, a suction fan, a foot-controlled water spray, and a fluorescent light. Each piece is coated individually, and the deposit makes it electrically conductive for immersion in a plating solution.

For mines free from explosive, gaseous atmospheres, Farmers Engineering & Manufacturing Company has provided an electronic system of communication by which all stations on a circuit can talk to or listen in on one another by means of a combination transmitting and receiving unit with speaker and microphone. The underground sets are mounted on mine locomotives and connected to that in the central dispatching

office through the trolley and ground. It is claimed that the system has a range under normal conditions of 3 or 4 miles.

Semitransparent plastic tubing made luminous by a radioactive substance was used extensively during the war and is now generally available. It is a product of United States Radium Corporation and is said to be visible for a considerable distance in complete darkness. The coating is applied to the inner surface. Tubing has an inside diameter of ¼ inch and is obtainable in specified lengths.

There are still rural areas in this country that are cut off from the outside world by telephone. This situation can be remedied without stringing the usual circuits, we are told, provided such sections are served by electric transmission lines. Experiments have revealed that conversations can "hitchhike" on power currents, and plans are now underway to establish telephonic communication of this kind in isolated regions in North and South Carolina, Vermont, Texas, Colorado, and Washington.

From an attachment designed to convert any standard bench vise into an air-operated unit, Van Products Company has gone a step farther and developed a self-contained vise complete with pneumatic cylinder and 3-way foot-control valve. Named Vi-Speed, the unit has a length with jaws closed of 29 inches and can be mounted horizontally or vertically, as may be most convenient

for the work to be performed. Operating air pressures range from 15 to 150 psi., giving unlimited jaw pressures up to 3½ tons to permit holding heavy as well as delicate pieces. Maximum jaw opening is 7 inches and maximum cylinder stroke 1¼ inches, an adjustable safety stop screw preventing jaws from traveling beyond set point. Slight toe pressure closes jaws and heel pressure releases work, the pedal that controls the air valve being locked in either position. Vi-Speed is equipped with an air-pressure regulator, gauge, quick-release air valve, hose, and handle for manual operation. Unit may be synchronized in multiple operation with single control to hold a piece of any length and varying thickness.

Industrial Literature

A multiangle vise that can be tilted and locked in any desired position is described in a folder issued by Manufacturers Engineering Service, Inc., Security Bank Building, Toledo, Ohio.

A circular selector that enables machinists quickly to determine proper speeds and feeds for eight types of Republic Enduro stainless steel may be had from Republic Steel Corporation, Cleveland 1, Ohio.

Hauck Manufacturing Company, 124 Tenth Street, Brooklyn 15, N.Y., has issued a new catalogue, No. 1043, describing its oil- and gas-burning equipment for foundry service.

The advantages of both fan-cooled and nonventilated types of totally enclosed motors for driving machine tools are described and illustrated in Bulletin MU-25A issued by Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis 14, Mo.

A new Fulface dust mask that provides complete facial and respiratory protection without obstructing vision is described in Bulletin No. CR-19 obtainable from Mine Safety Appliances Company, Braddock, Thomas, and Meade streets, Pittsburgh 8, Pa.

Industrial models of all kinds of equipment from engines to houses are often of aid to production and merchandising departments. A 4-page leaflet on their manufacture and uses is offered by Stark Industrial Models, 95 Jane Street, New York 14, N. Y.

Catalogue No. 8302, *Industrial Control Devices*, describes pneumatic and electric automatic-control systems produced by The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia 44, Pa. Pneumatic controls include temperature, pressure, and humidity controllers, motors and valves, and relays and switches.

Bituplastic, a new waterproofing and vapor-sealing plastic coating produced by Wailes Dove-Hermiston Corporation, Westfield, N. J., is described in a pamphlet available for distribution. The compound is recommended for use on tanks, gas holders, cooling towers, metal buildings, roofs, and railings. It can be applied with a brush or air spray.

The American Wage Earners Foundation, Room 605A, 30 North La Salle Street, Chicago 2, Ill., is offering free copies of *Communism in Action*, a government publication sponsored by Representative E. M. Dirksen of Illinois and printed as House Document No. 754. It was written by the Legislative Reference Service of the Library of Congress and is a factual presentation of how Communism has actually worked out in Russia.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., has issued a folder, Form 4051, describing its new 82-pound paving breaker, the PB-8. Improvements in design give this tool greater power than previous models. With two extra interchangeable frontheads, it can also be converted into a sheet-pile driver or a spike driver. Another recent Ingersoll-Rand publication is a revised edition of its bulletin on aftercoolers for removing moisture from compressed air or other gases. It summarizes the advantages of aftercooling and describes and illustrates the various types of I-R coolers available. The bulletin is designated as Form 3014-B.

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